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LOADS AND YIELDS OF NUTRIENTS AND SUSPENDED SEDIMENT TRANSPORTED IN THE SUSQUEHANNA RIVER BASIN, 1985–89

SUSQUEHANNA RIVER BASIN COMMISSION

SEPTEMBER 1991

PY

Loads and yields of
nutrients and suspended

The Susquehanna River Basin Commission was created as an independent agency by a Federal-Interstate Compact* among the States of Maryland, New York, Commonwealth of Pennsylvania and the Federal Government. In creating the Commission, the Congress and State Legislatures formally recognized the water resources of the Susquehanna River basin as a regional asset vested with local, State and National interests for which all the parties share responsibility. As the single Federal-Interstate water resources agency with basinwide authority, the Commission's goal is to effect coordinated planning, conservation, management, utilization, development and control of basin water resources among the government and private sectors.

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* Statutory Citations: Federal - Pub. L. 91-575, 84 Stat. 1509 (December, 1970); Maryland - Natural Resources Sec. 8-301 (Michie 1974); New York - ECL Sec. 21-1301 (McKinney 1973); and Pennsylvania - 32 P.S. 820.1 (Supp. 1976).

LOADS AND YIELDS OF NUTRIENTS AND SUSPENDED SEDIMENT TRANSPORTED IN THE SUSQUEHANNA RIVER BASIN, 1985-89

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CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer metric (International system) units rather than inch-pound units used in this report, values may be converted by using the following factors:

Multiply Inch-Pound Unit	By	To Obtain Metric Unit
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	0.4047	square hectometer (hm^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Volume	
cubic foot per second-days (cfs-days)	2,447	cubic meters (m^3)
	Mass	
pound per acre	1.121	kilogram per square hectometer (Kg/hm^2)
pound (lb)	0.4536	Kilogram (Kg)
ton (ton), short	0.9072	megagram (Mg)
ton per square mile (ton/mi^2)	0.3503	metric ton per square kilometer (t/km^2)

ABSTRACT

Excessive nutrients and sediments are suspected of causing a marked decrease in the productivity of the Chesapeake Bay, and much of the excess nutrients and sediment are thought to originate from the lower Susquehanna River basin. Annual loads of nutrients and suspended sediment transported by the main stem of the Susquehanna River and ten of its tributaries were measured from 1985 to 1989 to determine a 1985-89 nutrient baseline loading rate for the basin.

Data were collected monthly during base-flow conditions and during one stormflow event per season. Base-flow water discharge and concentrations of nutrients and suspended sediment varied seasonally. In most years, base-flow water discharge was highest during the winter and lowest during the summer at all sites. However, nutrient and suspended-sediment concentrations did not always vary in the same manner as water discharge at all sites. Seasonal variations in nutrients and suspended-sediment concentrations observed during periods of base flow and stormflow emphasize the need for periodic sampling of both base flow and stormflow throughout the year.

Regression analyses were performed to calculate annual and seasonal loads using a 7-parameter log-linear model incorporating seasonality, flow, and time trend variables.

Calculated annual loads and yields of nutrient and suspended sediment show year-to-year variabilities of these parameters for each site. These variabilities are highly correlated with those of annual water discharge. Loads and yields of nutrients and suspended sediment were adjusted to long-term values in order to facilitate between-site comparisons.

The Conestoga River at Conestoga was the only site to show a trend in nutrient loads. The 1989 total phosphorus load indicated a significant

reduction from that of previous years. The change appeared to be due primarily to an upgrading of a regional sewage treatment plant.

A comparison between suspended-sediment yields measured on the Susquehanna River at Harrisburg, Pa. during the periods 1962-67 and 1985-89 indicated little change in yields. This minor change over a 25-year period is consistent with the slow pace of development in the upper Susquehanna River basin.

The tributaries below Harrisburg show sizeable increases in sediment yields over the 25-year period. That is due to increased urban development rather than to farming. Sediment yields during 1962-67 primarily reflect farming practices and the beginning of the development boom. Farm land has decreased since the early 1960′s giving way to housing and commercial/industrial development.

The nutrient and suspended-sediment loads measured at Conowingo do not reflect total basin loads transported by the Susquehanna River and its tributaries. Total basin loads were estimated for each of the 5 years, 1985 to 1989, by adding the loads transported by the Susquehanna River at Harrisburg, loads of the sampled tributaries below Harrisburg, and estimated loads for the unmeasured tributaries. The computed 1985-to-1989 average annual baseline loading rates for total nitrogen, total phosphorus, and suspended sediment for the basin above Conowingo Dam were 150×10^6, 8.7×10^6, and $6{,}180 \times 10^6$ pounds, respectively. The total nitrogen, total phosphorus, and suspended-sediment loads for Conowingo were 147×10^6 and 5.13×10^6 pounds and $1{,}780 \times 10^6$ pounds, respectively. Based on the average annual 1985-to-1989 baseline load computed for Conowingo, $4{,}400 \times 10^6$ pounds, or 71 percent, of the annual sediment load is entrapped in the reservoirs.

This study has reinforced earlier investigators´s conclusions that the highest nutrient yields come from the lower Susquehanna River basin. This part of the basin constitutes nearly 19 percent of the drainage area, but contributes 28 percent of the average total phosphorus load, 38 percent of the average total nitrogen load, and 45 percent of the average suspended-sediment load.

INTRODUCTION

The Pa. Department of Environmental Resources, Bureau of Soil and Water Conservation and Bureau of Laboratories (Pa. DER), the U.S. Environmental Protection Agency (U.S. EPA), the U.S. Geological Survey (USGS), and the Susquehanna River Basin Commission (SRBC) have cooperated in a study to quantify nutrient and suspended sediment transport in the Susquehanna River basin. Nutrients and sediments entering the Chesapeake Bay from the Susquehanna River basin could contribute toward nutrient enrichment problems in the Bay (EPA, 1982).

Background

New York, Pennsylvania, Maryland, Virginia, and the District of Columbia have agreed to reduce nutrient loads to the Chesapeake Bay. The 1987 Chesapeake Bay Agreement states that by the year 2000, controllable excess nutrient loads to the bay are to be reduced to at least 60 percent of the 1985 average annual loading rate. Much of the excessive nutrients and suspended sediment that enter the Chesapeake Bay are thought to originate from the lower Susquehanna River basin. As part of the Pennsylvania Chesapeake Bay Program Reduction Strategy, the U.S. EPA estimated the 1985 average annual nutrient discharge of the Susquehanna River to the Chesapeake Bay to be 121 million pounds of nitrogen and 2.91 million pounds of phosphorus.

Several studies, Clark and others (1973, 1974); Poth (1977); Ward and Eckhardt (1979); Lietman and others (1983); and Ward (1987) showed high concentrations of nutrients in streams of the lower Susquehanna River basin. Other studies, Poth (1977); Lloyd and Growitz (1977); and Taylor and Werkheiser (1984) showed high concentrations of nutrients in ground water in the lower basin. Three of the studies showed high suspended-sediment yields from areas in the lower basin, Ward and Eckhardt (1979); Lietman and others (1983); and Ward (1987). Lang (1982) reported results of water-quality sampling of the three major tributaries to the Chesapeake Bay--the Susquehanna, Potomac, and James Rivers. Results from the above studies indicated a large nutrient load was being transported by the lower Susquehanna River and concluded that the sources and quantities of the loads warranted determination.

Objectives of the Study

The objectives of this study were to collect monthly base flow and seasonal-storm nutrient and suspended-sediment samples from the main stem of the Susquehanna River and from its major tributaries in the lower Susquehanna River basin and use the determined concentration data to compute annual nutrient and suspended-sediment loads and establish baseline loading rates. Annual loads were derived for most of the collection sites for calendar years 1985 through 1989. Annual load data that were calculated for total nitrogen, total phosphorus, and suspended sediment for the 1985-89 period were adjusted to baseline loads on the basis of the mean water discharge for the period of record for each respective gaged sampling site. In addition, nutrient and suspended-sediment loads were determined for several streams that drain areas of single, or nearly-single, land use. Nutrient-load data for single land uses are needed to aid in determining the relationship between land use and nutrient and suspended-sediment yields.

This study establishes a sound database which can be used to effectively plan, implement, and evaluate immediate and long-range nutrient reduction efforts.

Purpose of Report

The purpose of this report is to present basic information on annual and seasonal loads and yields of nutrients and suspended sediment measured during calendar years 1985 through 1989, and to document a 1985-89 baseline stream loads of nutrients in the basin. A method is provided for estimating "average baseline load". Such baseline loads are documented for total nitrogen (TN), total phosphorus (TP), and suspended sediment for sites on the main stem of the Susquehanna River and for 11 additional sites, which are mostly on tributaries of the lower Susquehanna River basin. Relations between average loads and yields and land use are presented. Total basin loads and the loads measured at Conowingo Dam by the USGS are also presented to provide insight into the significance of nutrient entrapment of run of river reservoirs that lie upstream of Chesapeake Bay.

DESCRIPTION OF THE SUSQUEHANNA RIVER BASIN

The Susquehanna River (figure 1) drains an area of 27,510 square miles (Susquehanna River Basin Study Coordination Committee, 1970) and is the largest tributary to the Chesapeake Bay. For the purpose of this study, the Susquehanna River basin is considered to have 27,100 square miles of drainage area above Conowingo Dam at Conowingo, Maryland.

The climate in the Susquehanna River basin varies considerably from the low lands adjacent to the Chesapeake Bay in Maryland to the high elevations, above 2,000 feet, of the northern headwaters in central New York State. The annual mean temperature ranges from 53°F (degrees Fahrenheit) near the Pennsylvania/Maryland border in the lower subbasin to 45°F in the northern end of the basin. Mean January temperatures range from 30°F in souther parts of the basin to 21°F in the northern parts of the basin. Mean July temperatures

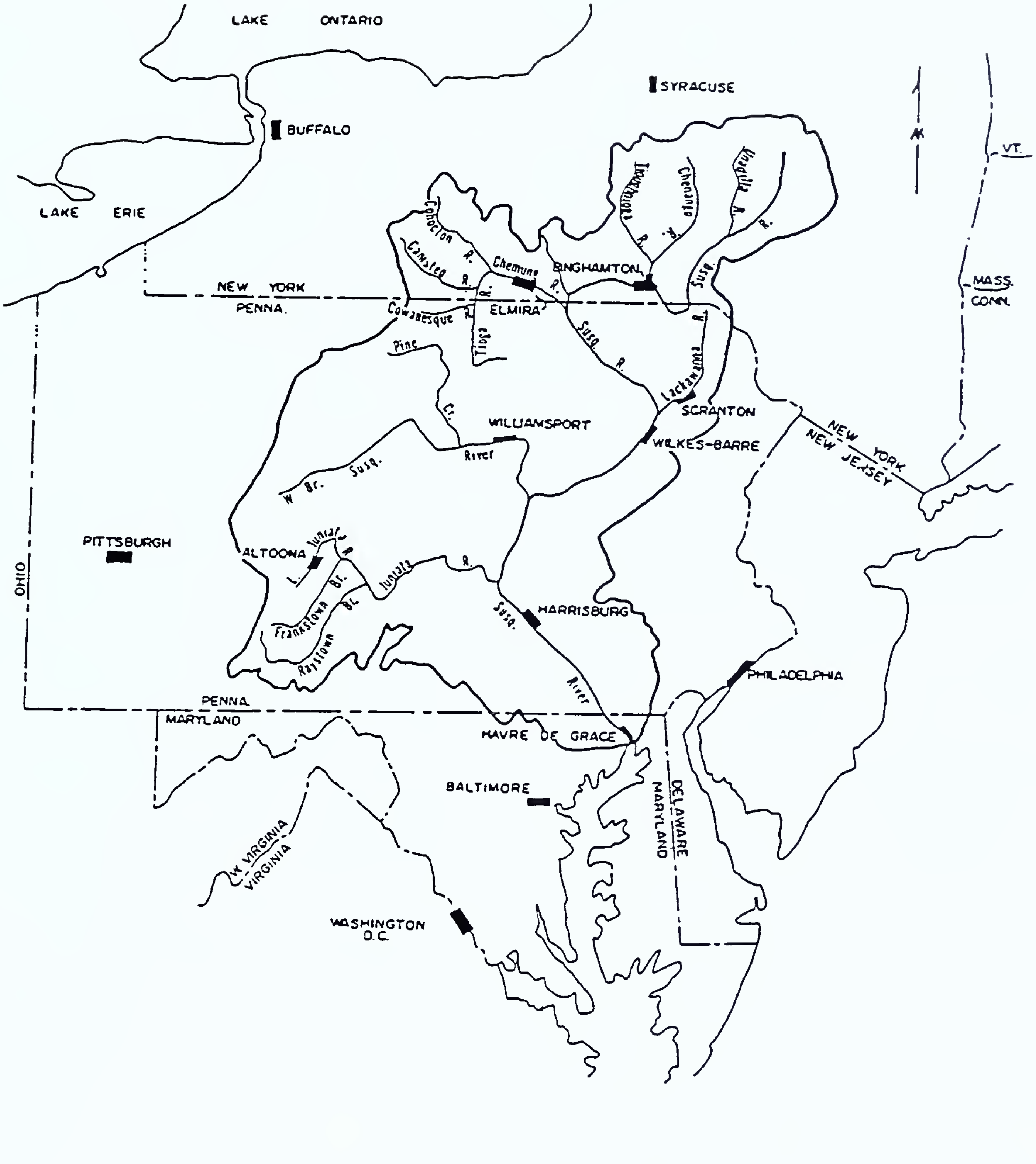


FIGURE 1.--Map showing Susquehanna River basin

range from 75°F to 67°F in these parts, respectively. Precipitation for the basin averages 39.15 in. (inches) per year, and is fairly well distributed throughout the year. The highest annual precipitation is in the Valley and Ridge and the Appalachian Plateau provinces (Fenneman, 1938) of central Pennsylvania and the lowest annual precipitation is southern New York State.

The average growing season in the southern parts of the basin is approximately 160 days and lasts from about May 1 to about October 10. The growing season in northern parts of the basin is roughly 120 days and extends from about May 15 to September 15. However, frosts can occur significantly later in the spring and earlier in the fall than the end dates of the average growing season.

Lands in the basin are predominantly forested. Woodland occupies the higher elevations of the northern and western areas of the basin and much of the mountain and ridge land in the two lower subbasin. Farmers in the northern subbasin use more tillable land for hay and less for cultivated crops because of the short and uncertain growing season. Most of the cultivated land is in the lower subbasin; however, extensive areas are cultivated along the river valleys in southern New York and along the West Branch Susquehanna River from Lock Haven to Northumberland, including much of the valley of Bald Eagle Creek.

Most of the urban areas in the basin are along the river valleys.

NUTRIENT MONITORING SITES

Several factors were considered when the data collection sites were selected. All major tributaries (those with drainage areas greater than 100 square miles) within the lower Susquehanna River basin were considered as were the three inflows from the upper Susquehanna River basin. The size of the drainage area and land use were considered because drainage area and land use are related to loads and yields of nutrients and suspended sediments.

Susquehanna River

Data were collected from the Susquehanna River at Danville. The drainage area above Danville is 11,220 square miles and includes part of north-central Pennsylvania (the Tioga River basin) and much of south-central New York. Data were collected from the West Branch Susquehanna River at Lewisburg, drainage area 6,847 square miles, and the Juniata River at Newport, drainage area 3,354 square miles. The West Branch Susquehanna River basin includes much of north-central Pennsylvania and the Juniata River basin includes much of the south-central area of the state (figure 1). The three sites together drain 77.9 percent of the total Susquehanna River basin, and 98.9 percent of the 21,661 square miles upper Susquehanna River basin. The Susquehanna River also was sampled at Harrisburg. The drainage area above Harrisburg is 24,100 square miles of which 2,396 square miles is considered to be in the lower basin (the drainage area between Sunbury and Harrisburg excluding the Juniata River basin). The Susquehanna River at Conowingo, Maryland, was sampled by the Mid-Atlantic District of the U.S. Geological Survey. The drainage area at Conowingo is 27,100 square miles, representing 98.5 percent of the 27,510 square mile basin.

Data also were collected from the Susquehanna River at Marietta from 1987 through 1989 and from the Susquehanna River at Towanda during 1989. The drainage area at Marietta is 25,990 square miles and the drainage area at Towanda is 7,797 square miles. Marietta was added as a sampling site because it better represents the inflow to the reservoirs on the lower Susquehanna River. Towanda was added because it represents the contribution from New York

State, although the drainage area does include the Tioga River basin in northern Pennsylvania and an area along the northern tier counties of eastern Pennsylvania.

Tributaries

Three sites were sampled primarily to determine the load and yield differences due to the effects of land use. Data were collected from Stony Creek at Water Tank Trail, near Dauphin because the stream represents drainage from an area that is 100 percent forested, from Paxton Creek near Penbrook because the stream drains an area that is about 70 percent suburban and 30 percent forested, and from the Codorus Creek at two sites--York and Pleasureville--because the difference between the two represents a 45-square-mile area that is predominantly urban.

Data were collected from five of the major tributaries to the lower Susquehanna River--Sherman Creek at Shermans Dale, Swatara Creek near Hershey, West Conewago Creek near Manchester, Codorus Creek at York and Pleasureville, and Conestoga River at Conestoga. The drainage area of these five streams at the sampling locations is 1,930 square miles and the drainage area of these five streams at their mouths is 2,088 square miles. The five streams represent 33.0 percent of the lower basin at the sampling locations and 35.7 percent of the lower basins at their mouths. Some water quality data were tabulated from data collected as part of the USGS National Stream Quality Accounting Network (NASQAN) and the USGS Hydrologic Benchmark Program. The data collection sites are listed in table 1, and their locations are shown on figure 2.

TABLE 1.--Data-collection sites and their drainage areas

USGS Identification Number	Station Name	Site Short Name	Drainage Area sq mi
01531500	Susquehanna River at Towanda, Pa.	Towanda	7,797
01540500	Susquehanna River at Danville, Pa.	Danville	11,220
01545600	*Young Womans Creek near Renovo, Pa.	Renovo	46.2
01553500	West Branch Susquehanna River at Lewisburg, Pa.	Lewisburg	6,847
01567000	Juniata River at Newport, Pa.	Newport	3,354
01568000	Sherman Creek at Shermans Dale, Pa.	Shermans Dale	200
01568750	Stony Creek at Water Tank Trail near Dauphin, Pa.	Dauphin	21.9
01570500	Susquehanna River at Harrisburg, Pa.	Harrisburg	24,100
01571000	Paxton Creek near Penbrook, Pa.	Penbrook	11.2
01573560	Swatara Creek near Hershey, Pa.	Hershey	483
01574000	West Conewago Creek near Manchester, Pa.	Manchester	510
01575500	Codorus Creek near York, Pa.	York	222
01575585	Codorus Creek at Pleasureville, Pa.	Pleasureville	267
01576000	Susquehanna River at Marietta, Pa.	Marietta	25,990
01576754	Conestoga River at Conestoga, Pa.	Conestoga	470
01578310	*Susquehanna River at Conowingo, Md.	Conowingo	27,100

* These sites are not part of this study. Data for these sites were collected by the Harrisburg, Pa. and the Towson, Md. offices of the U.S. Geological Survey.

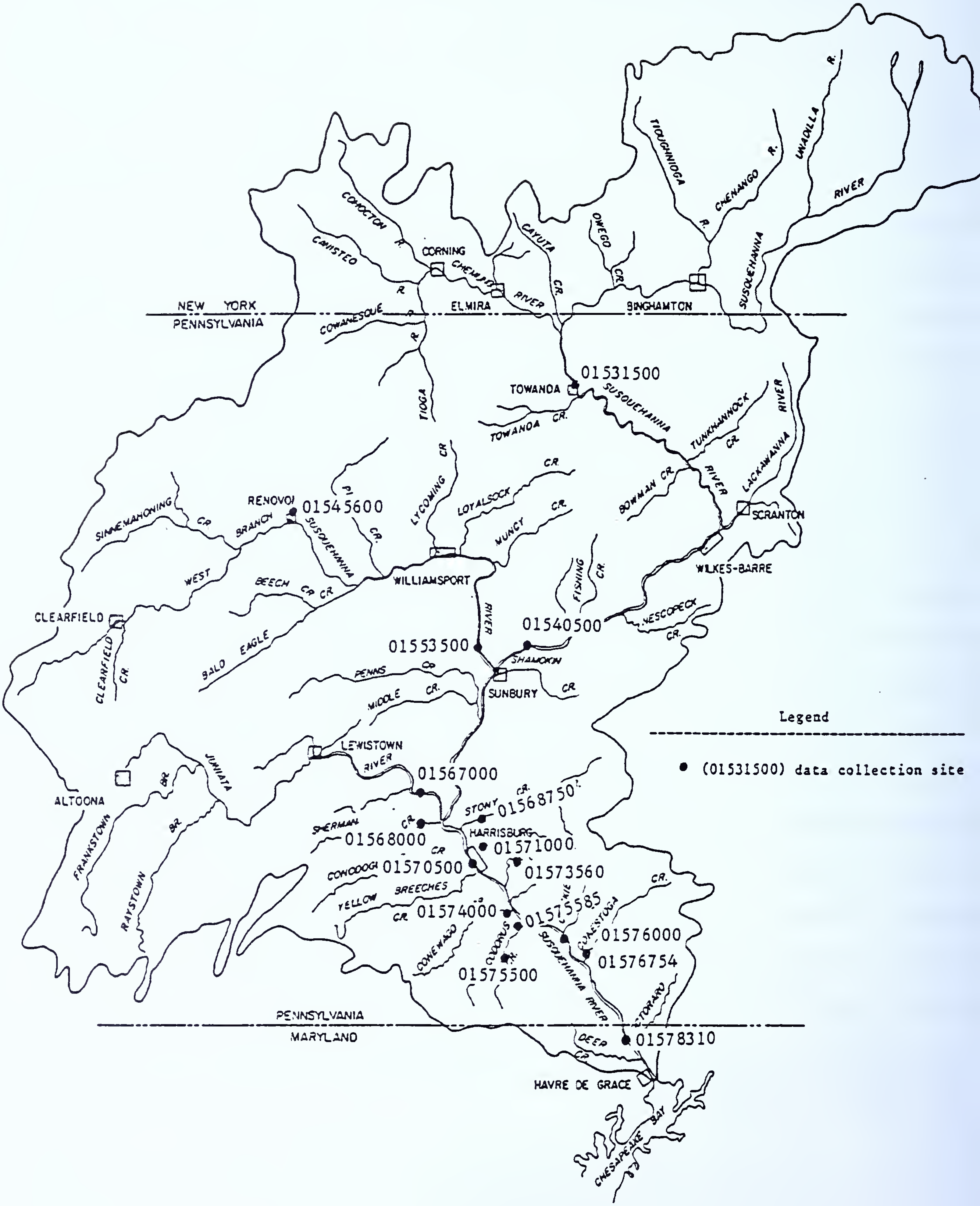


FIGURE 2.--Map showing locations of data-collection sites

SAMPLE COLLECTION AND ANALYSIS

Samples were collected at each of the sites to measure nutrient and suspended-sediment concentrations during periods of low and high flow. Samples of low flow were collected monthly. After a period of high flow, collection of low-flow samples was delayed, by 7 to 10 days, until moderate flows prevailed. All samples collected during periods of low flow were collected by hand with depth-integrating samplers. Samples were collected during three to eight periods of high flow each year. Storm, or high-flow, samples were normally collected every 4 hours from the start of the storm to the time when the flow receded to near its pre-storm rate. An attempt was always made to collect a sample at peak flow. Most storm samples were collected by hand with depth-integrating samplers; however, four of the sites were equipped with automatic pumping samplers.

A portion of each sample was filtered and the filtrate was analyzed for dissolved nitrogen and phosphorus species. Whole-water samples were analyzed for total nitrogen and total phosphorus species, total organic carbon, and suspended sediment. Samples for nutrient analysis either were delivered to the Pa. DER laboratory in Harrisburg or were shipped to the USGS National Water Quality Laboratory in Arvada, Colo., the day following sample collection. The parameters and laboratory methods used are listed in table 2. Samples collected for suspended-sediment concentrations were analyzed by the USGS Sediment Laboratory in Harrisburg. A particle-size distribution of suspended sediment was determined for a few samples of high suspended-sediment concentrations.

Duplicate and replicate samples were collected on a regular basis. A larger-than-normal volume of water was collected and two sets of filtered and whole-water samples of the same volume of water (duplicate samples) were sent

TABLE 2.--Water-quality parameters, laboratory methods, and detection limits

Parameter	Laboratory	Methodology	Detection Limit mg/l	Reference
Ammonia	USGS	Colorimetry	0.002	Skougstad, et al, 1979 (I-2523-78)
	Pa. DER	Colorimetry	.02	Standard Methods #4170
Kjeldahl nitrogen (dissolved)	USGS	Block digest, colorimetry	.2	Skougstad, et al, 1979 (I-4552-78)
	Pa. DER	Block digest, colorimetry	.2	U.S. EPA 351.2
Kjeldahl nitrogen (total)	USGS	Block digest, colorimetry	.2	Skougstad, et al, 1979 (I-4552-78)
	Pa. DER	Block digest, colorimetry	.2	U.S. EPA 351.2
Nitrite plus nitrate	USGS	Cd-reduction, colorimetry	.01	Skougstad, et al, 1979 (I-2545-81)
	Pa. DER	Cd-reduction, colorimetry	.01	U.S. EPA 353.2
Organic Carbon (total)	USGS	Wet oxidation	.1	Wershaw, et al. (0-3100-83)
	Pa. DER	Wet oxidation	.1	U.S. EPA 415.2
Ortho-phosphate (dissolved)	USGS	Colorimetry	.001	Skougstad, et al, 1979 (I-2601-81)
	Pa. DER	Colorimetry	.005	U.S. EPA 365.4
Phosphorus (dissolved)	USGS	Block digest, colorimetry	.001	Skougstad, et al, 1979 (I-2600-81)
	Pa. DER	Digest, colorimetry	.02	U.S. EPA 365.4
Phosphorus (total)	USGS	Block digest, colorimetry	.001	Skougstad, et al, 1979 (I-4600-81)
	Pa. DER	Persulfate digest, colorimetry	.02	Standard methods, 1985

to the Pa. DER laboratory marked with slightly different times (duplicate intra-laboratory samples). Duplicate inter-laboratory samples were collected the same way, but one sample was sent to the Pa. DER laboratory and one sample was sent to the USGS laboratory in Arvada, Colo. At the sites equipped with automatic samplers, depth-integrated samples (replicates) were collected on a regular basis to determine if the automatic samplers were collecting representative samples of the cross section. All duplicate and replicate samples were analyzed for the same constituents as the regular samples. An analysis of the duplicate and replicate samples is included in Appendix A--Quality Assurance of Nutrient and Sediment Data.

PRECIPITATION

Most precipitation data were obtained from long-term stations operated by the U.S. Department of Commerce. Data for part of the Conestoga River basin were obtained from the Conestoga River headwaters project of the USGS. The U.S. Department of Commerce data are published monthly as Climatological Data-Pennsylvania, and as Climatological Data-New York by the National Oceanic and Atmospheric Administration (NOAA) at the National Climatic Data Center in Asheville, North Carolina. Quarterly and annual precipitation data from these sources were summarized for the period from 1985 through 1989 for nine regions in the Susquehanna River basin: the Susquehanna River basin above Danville, the West Branch Susquehanna River basin, the Young Womans Creek basin, the Juniata River basin, the Sherman Creek basin, the Swatara Creek basin, the West Conewago Creek basin, the Codorus Creek basin, and the Conestoga River basin. This summary is shown in table 3, along with average long-term precipitation values for the period 1985-89.

TABLE 3.--Summary of annual precipitation for selected subbasins in the Susquehanna River basin, calendar years 1985 through 1989

Subbasin	Season	Average Long-term Precipation	Calendar Years				
			1985	1986	1987	1988	1989
		inches					
Susquehanna River above Danville	January-March	8.06	6.25	7.85	4.66	5.53	6.31
	April-June	9.99	8.42	11.25	10.41	7.18	15.03
	July - September	10.24	12.09	11.74	13.36	11.28	9.30
	October-December	8.77	9.53	9.86	6.44	6.69	7.65
	Yearly total	37.06	36.29	40.70	34.87	30.68	38.29
West Branch Susquehanna River	January-March	9.16	7.00	7.71	5.28	6.23	8.54
	April-June	11.54	9.52	10.56	11.79	7.45	15.92
	July - September	11.46	10.15	11.99	14.24	12.37	9.46
	October-December	9.44	10.99	11.87	7.43	6.75	7.10
	Yearly total	41.60	37.66	42.13	38.74	32.80	41.02
Young Womans Creek	January-March	8.83	7.03	7.08	4.27	5.82	6.45
	April-June	11.42	8.93	13.26	13.87	8.36	14.45
	July-September	11.50	11.54	12.24	15.11	11.87	9.88
	October-December	9.25	11.35	11.25	6.88	6.01	6.28
	Yearly total	41.00	38.85	43.83	40.13	32.06	37.06
Juniata River	January-March	9.21	8.47	9.16	6.22	7.33	8.68
	April-June	11.58	10.31	9.39	11.26	8.42	13.66
	July - September	11.38	8.00	9.03	11.29	9.17	13.75
	October-December	9.23	13.90	12.42	7.56	7.32	6.96
	Yearly total	41.40	40.68	40.00	36.33	32.24	43.05

TABLE 3.--Summary of annual precipitation for selected subbasins in the Susquehanna River basin, calendar years 1985 through 1989--Continued

		Average Long-term Precipa-tation	Calendar Years				
			1985	1986	1987	1988	1989
Subbasin	Season	inches					
Sherman Creek	January-March	9.09	7.90	9.00	6.30	5.30	11.30
	April-June	11.41	8.90	10.40	11.50	11.30	18.84
	July-September	11.41	8.50	9.88	11.10	10.03	15.70
	October-December	10.09	10.60	10.30	7.00	6.80	8.68
	Yearly total	42.00	35.90	39.58	35.90	33.43	54.52
Swatara Creek	January-March	9.78	6.19	11.10	7.84	6.33	6.76
	April-June	11.88	9.81	9.58	10.62	8.48	16.03
	July-September	12.20	8.40	13.03	13.42	13.18	13.23
	October-December	10.24	8.85	12.90	8.49	7.38	8.99
	Yearly total	44.10	33.25	46.61	40.37	35.37	45.01
West Conewago Creek	January-March	9.57	8.21	8.73	6.24	6.53	9.36
	April-June	11.69	9.64	9.11	10.57	11.29	15.82
	July-September	10.89	15.43	8.45	13.18	10.24	9.13
	October-December	9.75	11.82	12.72	8.98	6.68	8.63
	Yearly total	41.90	45.10	39.01	38.97	34.74	42.94
Codorus Creek	January-March	9.45	6.96	8.32	6.75	7.17	9.63
	April-June	11.54	10.06	7.73	9.45	8.92	14.59
	July-September	10.97	12.80	9.40	10.66	9.39	8.91
	October-December	9.54	9.72	11.98	9.05	6.84	8.63
	Yearly total	41.50	39.54	37.43	35.91	32.32	41.76

TABLE 3.--Summary of annual precipitation for selected subbasins in the Susquehanna River basin, calendar years 1985 through 1989--Continued

Subbasin	Season	Average Long-term Precipatation	Calendar Years				
			1985	1986	1987	1988	1989
		inches					
Conestoga River	January-March	8.48	5.28	8.02	4.95	7.10	8.32
	April-June	11.01	9.91	8.03	9.24	9.28	15.77
	July-September	11.60	13.05	16.97	15.39	15.86	11.96
	October-December	9.33	7.93	12.58	7.95	7.60	9.22
	Yearly Total	40.42	36.62	45.60	37.53	39.84	45.27

Average precipitation in the Susquehanna River basin above Conowingo is about 39.80 in/yr. Average precipitation for the 5 years from 1985 through 1989 was about 37.76 inches, or about 2 inches below normal. The driest year was 1988 when only 32.40 inches was recorded, and the average for the other 4 years was 39.10 inches. The two wettest years were 1986, at 41.25 inches, and 1989 at 40.80 inches.

Annual precipitation exceeded the normal annual mean in all basins at least once during the study and it exceeded the annual mean twice in four of the basins. The greatest annual precipitation occurred in the Sherman Creek basin in 1989. Precipitation totaled 54.52 inches during the year and was 12.50 inches above normal. The prior year only 33.43 inches precipitation fell in the basin, which was 8.50 inches below normal.

The Conestoga River basin also had large variations in annual precipitation. During 1985, precipitation in the Conestoga River basin totaled 36.62 inches, but during 1986 it totaled 45.23 inches. Most of the heavy precipitation of 1986 fell during the July-September period. For the 3 months, precipitation totaled 16.97 inches, or about 5.00 inches above normal.

WATER DISCHARGE

Measured annual water discharges for the period of data collection are listed in table 4 for all sites. Also, listed in table 4 is the long-term mean discharge for most of the sites. The long-term means listed for Swatara Creek, Codorus Creek at Pleasureville, Conestoga River and the Susquehanna River at Conowingo are values adjusted from intermediate-term means that were compared to means for long-term gages located upstream of each of the four sites. The long-term mean listed for Stony Creek was adjusted with the flow record for the adjacent stream to the north, Clark Creek.

TABLE 4. Annual water discharge, calendar years 1985 through 1989

		Water discharge											
		Long-term Annual Mean		1985		1986		1987		1988		1989	
Site Short Name	Years of Record	cfs	inches	Mean cfs	Long-term Mean percent	Mean cfs	Long-term Mean percent	Mean cfs	Long-term Mean percent	Mean cfs	Long-term Mean percent	Mean cfs	Long-term Mean percent
Towanda	76	10,500	18.3	--	--	--	--	--	--	--	--	10,100	95.4
Danville	90	15,300	18.5	11,200	73.5	17,400	114	12,900	84.3	10,600	69.6	14,900	97.8
Renovo	24	73.7	21.7	63.9	86.7	80.5	109	52.4	71.1	45.6	61.9	68.4	92.8
Lewisburg	50	10,800	21.5	9,690	89.6	12,000	111	9,270	85.7	7,680	71.0	10,800	99.8
Newport	90	4,290	17.4	3,910	91.1	3,960	92.3	3,560	83.0	3,140	73.2	5,190	121
Shermans Dale	60	288	19.6	214	74.3	240	83.3	235	81.6	197	68.4	377	131
Dauphin	50 1/	38.9	24.1	24.8	63.7	37.6	96.6	--	--	--	--	--	--
Harrisburg	99	34,200	19.3	26,300	76.8	35,400	104	27,700	80.8	23,100	67.6	33,500	98.0
Penbrook	14	14.6	17.7	8.4	57.5	15.2	104	15.5	106	14.2	97.3	--	--
Hershey	70 2/	814	22.9	443	54.4	772	94.8	668	82.1	564	69.3	866	106
Manchester	60	588	15.7	423	71.9	562	95.6	528	89.8	387	65.8	709	121
York	49 3/	218	13.3	176	80.7	175	80.3	168	77.1	169	77.5	197	90.4
Pleasureville	49 4/	295	15.0	248	84.1	247	83.7	251	85.1	244	82.7	281	95.3
Marietta	58	36,700	19.2	--	--	--	--	30,600	83.4	25,300	68.8	37,500	102
Conestoga	59 5/	587	17.0	428	72.9	671	114	599	102	651	111	794	135
Conowingo	58 6/	38,300	19.2	30,500	79.5	41,200	108	32,300	84.2	27,100	70.7	40,100	105

1/ Adjusted based on Clark Creek near Carsonville
2/ Adjusted based on Swatara Creek at Harper Tavern
3/ Not adjusted for diversion
4/ Adjusted based on Codorus Creek near York, includes diversion by York Water Company
5/ Adjusted based on Conestoga River at Lancaster
6/ Adjusted based on Susquehanna River at Marietta

Also, presented in table 4 are annual water discharges as percentages of the long-term mean.. A percentage less than 100 indicates a year with below-normal water discharge and percentage over 100 indicates a year with above-normal water discharge. The year with the least water discharge at Conowingo was 1988 (70.7 percent of normal), and the year with the most water discharge at Conowingo was 1986 (107.6 percent of normal). Streamflow ranged from 57.5 percent of normal in Paxton Creek during 1985 to 130.9 percent of normal in Sherman Creek during 1989.

With the exceptions of the Susquehanna River at Towanda (only 1 year of nutrient and suspended-sediment data) and the two sites on Codorus Creek (York and Pleasureville), each site had at least 1 year of flow greater than its long-term mean.

Water discharge in Codorus Creek is highly regulated. Examination of the precipitation and streamflow data in tables 3 and 4 discloses a much greater variability in annual precipitations than in mean annual water discharges. Summer and fall streamflow conditions were described to the authors by P. H. Glatfelter Company personnel (Carter, N. and Metzger, L., oral communication, 1990). P. H. Glatfelter Company maintains a flow in Codorus Creek at the Spring Grove processing plant of 15-18 mgd by releasing water from Lake Marburg. This flow must be maintained to meet permit limits for an industrial-waste discharge point downstream. Approximately a mile downstream of the plant, P. H. Glatfelter Company discharges 13-14 mgd of treated effluent. Consequently, the regulated component of flow in Codorus Creek upstream of the South Branch Codorus Creek at Indian Rock Dam averages approximately 31 mgd. York Water Company operates a pumping station at the mouth of the South Branch Codorus Creek where it is required to maintain a flow no less than 3.8 mgd, which is partly derived from two upstream reservoirs. The combined flow of the two creeks is approximately 36 mgd at the USGS gage in West York, just upstream of Richland Avenue. About 37 percent of this flow is the treated discharge from P. H. Glatfelter Company. Two sewage treatment plants (STPs) lie downstream of the City of York. The York STP discharges approximately 15 mgd, and Springettsbury STP discharges 10 mgd. Water removed from the South Branch via the York Water Company does not re-enter Codorus Creek until it is treated at the two STPs; thus, it bypasses the USGS gage at West York. Flows at the mouth of Codorus Creek average 65-70 mgd, of which 60 percent is treated.

The depth equivalent of long-term average discharge is significantly greater at Lewisburg than at Danville. This is probably because the Lewisburg basin has the higher annual precipitation. The average annual precipitation in the basin above Lewisburg is 41.60 inches, which is 12 percent more than the 37.06 inches in the basin above Danville.

Long-term discharge from the West Conewago Creek, the Codorus Creek, and the Conestoga River basins is less than long-term runoff from the upper Susquehanna River basin. Long-term discharge from the West Conewago Creek basin is 15.65 in. The long-term discharge from the Codorus Creek basin above York, after adjusting for diversion, was 14.99 in, and long-term discharge from the Conestoga River basin is 16.95 in. Long-term discharge from the Susquehanna River basin above Harrisburg is 19.27 in.

LAND USE

Land use in the Susquehanna River basin is predominantly rural. Woodland accounts for 63 percent of land use; grassland, 7 percent: cultivated, 19 percent; and urban, 9 percent. Woodland occupies the higher elevations of the northern and western basin and much of the mountain and ridge land in the Juniata and the lower Susquehanna River basin. Most of the grassland is in the northern basin. Farmers in the northern basin use more land for pasture and hay and less for cultivated crops because of the shorter and more uncertain growing season. Woods and grasslands occupy areas in the lower basin that are unsuitable for cultivation because the slopes are too steep, the soils are too stony, or the soils are poorly drained.

Most of the cultivated land is in the lower basin, however, extensive areas are cultivated along the river valleys in southern New York and along the West Branch Susquehanna River from Northumberland to Lock Haven, including the Bald Eagle Creek valley. Major urban areas in the lower basin include the York, Lancaster, Harrisburg, and Sunbury areas. Most of the urban areas in the northern basin are along the river valleys. They include the Binghamton and the Elmira-Corning areas in New York, and the Scranton and Wilkes-Bare areas in Pennsylvania. The major urban areas in the West Branch Susquehanna River basin are the Williamsport and Lock Haven areas.

Using county based agricultural data, Hannawald (Chesapeake Bay Liaison Office, U.S. EPA, written communication, 1989) tabulated land use and manure information by subbasins for the Susquehanna River basin. A summary of that data for 1985 is listed in table 5 for the basins where nutrient data were collected.

BASE-FLOW NUTRIENT AND SUSPENDED-SEDIMENT CONCENTRATIONS

Summary statistics (maximums, minimums and means) of base-flow data for all sites are categorized by season and period of record and provided in Appendix B. Nutrient concentration data for three contrasting sites are presented and discussed in detail as examples of how base-flow nutrient concentrations vary throughout the year. This concentration variation is a significant factor in load determination because the concentration and

TABLE 5. Land use and animal manure production for selected subbasins in the Susquehanna River basin, 1985 (after Hannawald, 1989)

Subbasin	Cropland							Annual Manure Production	
	Conservation Tilled	Conventional Tilled	Pasture	Total Agricultural	Forested	Urban	Water	Agricultural Area	Total Area
	percent							tons per acre	
Susquehanna River above Danville	2.1	15.9	8.4	26.4	59.8	11.3	2.5	3.03	0.80
Young Womans Creek above gage	0	0	0	0	99.7	0	.28	0	0
West Branch Susquehanna River above Lewisburg	3.3	6.2	4.4	13.9	81.0	4.6	.43	2.46	.34
Juniata River above Newport	8.7	10.9	5.6	25.2	68.8	5.1	.87	3.23	.81
Sherman Creek above Shermans Dale	13.4	7.7	3.2	24.4	70.2	5.0	.35	3.12	.76
Stony Creek above Water Tank Trail	0	0	0	0	99.7	0	.28	0	0
Susquehanna River above Harrisburg	4.4	12.2	6.4	23.0	67.0	8.4	1.56	2.94	.68
Paxton Creek above gage	0	0	39.8	39.8	18.6	41.2	.31	.014	.0014
Swatara Creek above Hershey	11.0	28.6	6.0	45.6	37.2	16.9	.37	3.89	1.77
West Conewago above Manchester	32.3	14.1	10.7	57.1	35.4	7.0	.51	2.45	1.40
Codorus above York	27.1	14.6	8.9	50.6	39.7	8.4	1.34	2.58	1.30
Codorus above Pleasureville	24.0	13.0	7.9	44.9	35.2	18.7	1.23	2.44	1.10
Susquehanna River above Marietta	5.8	12.6	6.5	24.9	64.7	8.9	1.51	3.05	.76
Conestoga River above Conestoga	22.8	29.1	10.8	62.7	14.6	22.4	.26	8.36	5.24
Susquehanna River above Conowingo	6.3	13.1	6.7	26.1	63.1	9.3	1.47	3.48	.91

corresponding discharge data are used to determine the nutrient loads. The Susquehanna River at Danville is located in the upper basin where a large urban area borders the river. Sherman Creek drains an area in the mid-section of the basin with mixed land uses and without any major population centers. The Conestoga River drains a largely agricultural area that contains a large urban center with a major regional sewage-treatment plant.

Water discharge and concentrations of nutrients and suspended sediment in samples collected during base-flow periods were averaged for each month and analyzed to determine seasonal trends and the percentage of the annual loads carried by base flows. For purposes of this report, the seasons are defined as winter (January, February, and March), spring (April, May, and June), summer (July, August, and September), and fall (October, November, and December).

Susquehanna River at Danville, Pa.

The monthly mean water discharges and monthly mean concentrations of nutrients and suspended sediment are listed in table 6 for the period 1985-89.

Concentrations of nitrite plus nitrate, total ammonia, and suspended sediment varied more than 100 percent from summer to winter. Nitrite plus nitrate concentrations (as nitrogen) averaged 0.52 mg/l during summer, and 1.13 mg/l during winter. Total ammonia concentrations (as nitrogen) averaged 0.04 mg/l during summer and 0.12 mg/l during winter. Concentrations of suspended sediment were lower in winter, averaging 12 mg/l, than in summer, 16 mg/l. Total organic nitrogen was higher in summer than in winter, 0.57 versus 0.41 mg/l. However, the increase in organic nitrogen concentrations in summer was not enough to offset the lower concentrations of nitrite plus nitrate and ammonia; consequently, concentrations of total nitrogen also were

TABLE 6.--Monthly mean base-flow discharge and corresponding monthly mean concentrations of nutrients and suspended sediment transported by the Susquehanna River at Danville, Pa., calendar years 1985-89

Month	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Total Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs	mg/l						
January	7,000	1.10	0.14	0.46	1.70	0.025	0.06	9
February	7,400	1.20	.14	.42	1.76	.025	.06	11
March	15,200	1.10	.07	.35	1.52	.025	.06	15
April	13,700	.90	.05	.50	1.45	.035	.07	19
May	8,000	.58	.04	.86	1.48	.020	.07	21
June	5,600	.53	.03	.80	1.36	.040	.11	20
July	4,200	.50	.05	.58	1.13	.035	.09	19
August	3,600	.50	.04	.60	1.14	.020	.07	16
September	3,000	.56	.02	.52	1.10	.030	.08	13
October	5,600	.70	.04	.44	1.18	.020	.05	11
November	8,100	.89	.06	.43	1.38	.020	.05	9
December	14,000	.96	.10	.42	1.48	.025	.06	8

lower in summer than in winter, 1.12 versus 1.66 mg/l. Concentrations of dissolved and total phosphorus were higher in summer, 0.028 and 0.08 mg/l, respectively, than in winter, 0.025 and 0.06 mg/l, respectively. Monthly values of mean base flows and concentrations of nitrite plus nitrate are plotted in figure 3 to illustrate their seasonal variations. Monthly mean base flows and concentrations of nitrite plus nitrate for the West Branch Susquehanna River at Lewisburg; and for the Susquehanna River at Danville, Harrisburg and Marietta are shown. Nitrite plus nitrate was selected for this illustration because it is highly mobile and shows the most site-to-site variability.

As seen in the figure at Danville, Harrisburg and Marietta, the highest concentrations generally occurred in winter and the lowest concentrations in summer. Nitrite plus nitrate concentrations at Lewisburg were generally highest in winter and lowest in spring, but showed only slight seasonal variations when compared to concentrations at the other sites. Seasonal concentrations differed markedly from site to site even though monthly water discharges, in cubic feet per second per square mile, were nearly the same for all sites.

If it is assumed that the observed monthly mean concentrations are typical of those base flows, they can be used to compute monthly base-flow loads of nutrients and suspended sediment. The sum of these monthly base-flow loads would then be an estimate of the yearly average base-flow loads, which can then be subtracted from the annual loads reported in tables 26 through 35, so as to determine the weights and percentages of nutrient and suspended-sediment loads transported in base flow and storm runoff.

Table 7 lists the monthly base-flow loads of nutrients and suspended sediment that were calculated from water-discharge and concentration data.

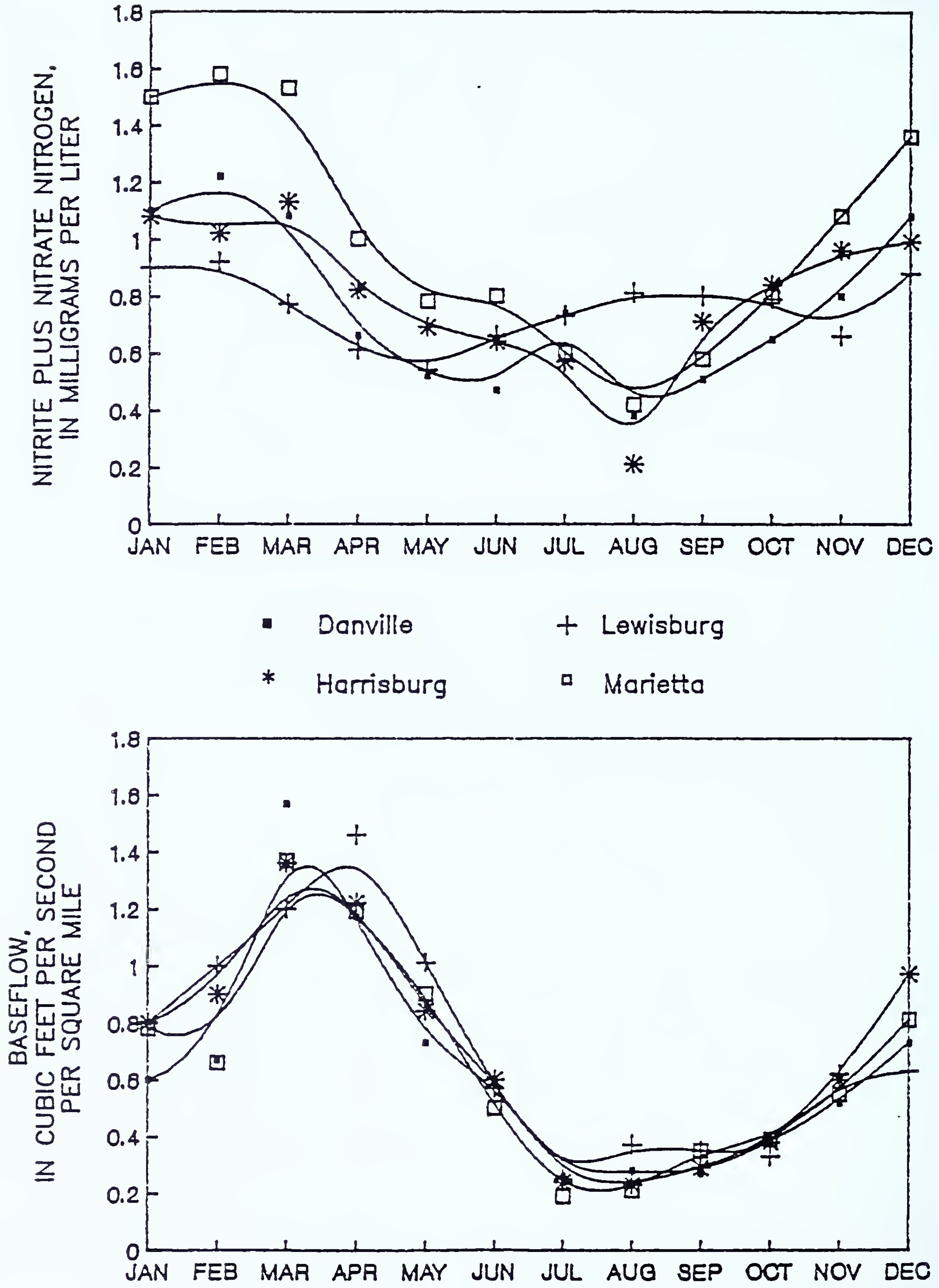


FIGURE 3.--Monthly mean base flow and nitrite plus nitrate nitrogen concentrations for the Susquehanna River at Danville, Pa., and three other principal sites, 1985-89

TABLE 7.--Monthly and annual mean base-flow discharge, nutrient, and suspended-sediment loads transported by the Susquehanna River at Danville, Pa., calendar years 1985-89

Month	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Organic Nitrogen as N	Total Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs	thousands of pounds						
January	7,000	1,290	164	539	1,990	29.3	70.3	10,600
February	7,400	1,340	157	470	1,970	28.0	67.1	12,300
March	15,200	2,800	178	890	3,870	63.6	153	38,200
April	13,700	2,000	111	1,110	3,220	77.7	155	42,200
May	8,000	777	26.8	1,150	1,990	26.8	93.7	28,100
June	5,600	481	27.2	726	1,240	36.3	99.8	18,100
July	4,200	351	35.2	408	794	24.6	63.3	13,400
August	3,600	301	24.1	362	684	12.1	42.2	9,640
September	3,000	272	32.4	253	535	14.6	38.9	6,320
October	5,600	656	37.5	412	1,100	18.7	46.9	10,300
November	8,100	1,170	78.7	564	1,800	26.2	65.6	11,800
December	14,000	2,250	234	984	3,470	58.6	141	18,800
Annual	7,960	13,700	1,110	7,870	22,700	416	1,040	220,000

The mean base-flow discharge of the Susquehanna River at Danville was 7,960 cfs in the period 1985-89, which is equivalent to 52 percent of the long-term mean water discharge (15,300 cfs) and 59 percent of mean flow during the 5 years of data collection (13,000 cfs). During base-flow periods, 59 percent of the nitrite plus nitrate, 51 percent of the total nitrogen, 34 percent of the total phosphorus, and 11 percent of the suspended sediment was transported. Monthly base-flow loads of all constituents were much higher during winter than during summer. The total nitrite plus nitrate load during winter was 5,430,000 pounds, or nearly six times that of the summer months.

Sherman Creek at Shermans Dale, Pa.

Concentrations of nutrients and suspended sediment in the samples collected from Sherman Creek during periods of base flow are summarized in Table 8. Concentrations of nitrite plus nitrate were highest in the base-flow samples collected during winter, but concentrations of total ammonia, total organic nitrogen, dissolved and total phosphorus, and suspended sediment were highest in the base-flow samples collected during the summer months. Seasonal variations in constituent concentrations at Shermans Dale differed from those observed at Danville, except for nitrite plus nitrate. Nitrite plus nitrate concentrations in the base-flow samples averaged 1.55 mg/l during winter and 0.68 mg/l during summer. Total ammonia and total organic nitrogen concentrations averaged 0.023 and 0.29 mg/l, respectively, during winter, and 0.042 and 0.38 mg/l, respectively, during summer. Concentrations of total nitrogen averaged 1.86 mg/l during winter and 1.10 mg/l during summer. Dissolved and total phosphorus concentrations averaged 0.022 and 0.028 mg/l during winter, and 0.037 and 0.057 mg/l during summer. Suspended-sediment concentrations averaged 5 mg/l during winter and 8 mg/l during summer.

TABLE 8.--Monthly mean base-flow discharge and corresponding monthly mean concentrations of nutrients and suspended sediment transported by Sherman Creek at Shermans Dale, Pa., calendar years 1985-89

	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Ortho-phosphate as P	Total Phosphorus as P	Suspended Sediment
Month	cfs	mg/l						
January	120	1.49	0.030	0.38	0.020	0.005	0.025	6
February	172	1.59	.025	.22	.025	.003	.033	4
March	204	1.57	.015	.27	.025	.003	.025	5
April	201	.96	.020	.33	.030	.004	.040	6
May	167	.83	.035	.50	.025	.004	.050	5
June	90	.78	.070	.43	.040	.005	.050	15
July	48	.72	.038	.38	.040	.007	.060	10
August	32	.43	.038	.36	.035	.003	.060	6
September	50	.90	.050	.41	.035	.006	.055	9
October	51	.89	.020	.26	.022	.006	.030	6
November	120	1.12	.018	.27	.025	.006	.040	5
December	181	1.67	.020	.29	.022	.006	.035	3

Monthly values of mean base flows and nitrite plus nitrate concentrations are plotted in figure 4 for Sherman Creek, Paxton Creek, Swatara Creek, West Conewago Creek, Codorus Creek at York, and the Conestoga River. Nitrite plus nitrate concentrations for Sherman Creek were highest in winter and lowest in summer. This seasonal variation in concentrations was generally the same for the other sites, except for Swatara Creek which had the highest concentrations in summer. Generally, the highest concentrations coincided with the highest base flows at each of the sites, except for Swatara Creek where low concentrations occurred in the high flows. Seasonal concentrations differed significantly from site-to-site, even when water discharges were similar.

Table 9 lists the mean water discharges in Sherman Creek, during the base-flow sampling period, and the monthly and annual base-flow loads of nutrients and suspended sediment. The mean base-flow discharge in the period 1985-89 (119 cfs), equals 41 percent of the long-term mean water discharge (288 cfs), and 47 percent of the water discharged during the 5 years of data collection. The mean base-flow load of nitrite plus nitrate transported by Sherman Creek during the period of 1985-89 was 286,000 lbs/year, or 42 percent of the annual load. The suspended-sediment load transported by base flow was 1,370,000 lbs/yr, or 3.2 percent of the annual sediment load.

The total nitrogen load transported by base flow averaged 371,000 lbs/yr, or 35 percent of the annual total nitrogen load. The total phosphorus load transported by base flow was 8,990 lbs/yr, or 17 percent of the annual total phosphorus load.

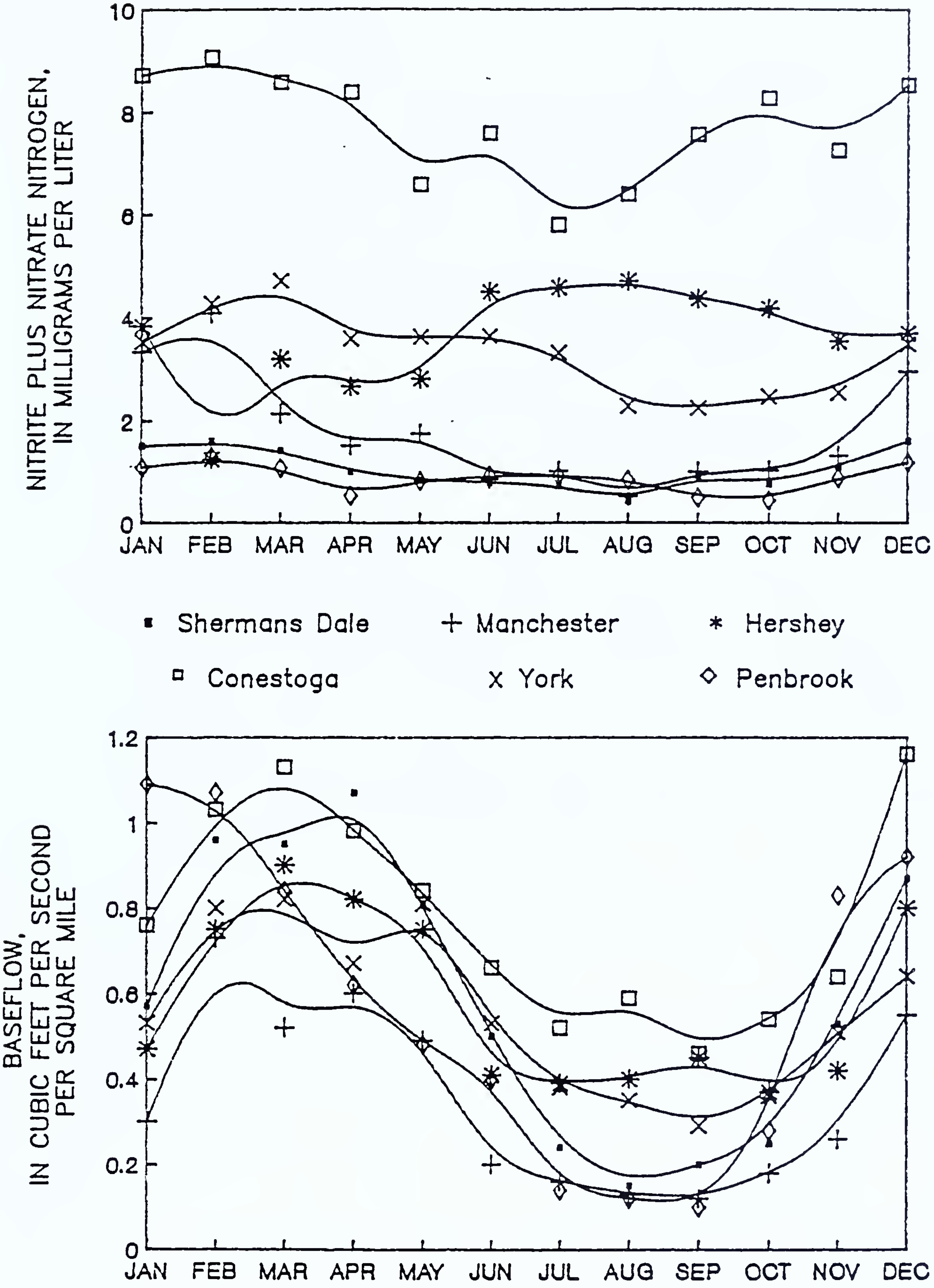


FIGURE 4.--Monthly mean base flow and nitrite plus nitrate nitrogen concentrations for Sherman Creek at Shermans Dale, Pa., and other tributary streams, 1985-89

TABLE 9.--Monthly and annual mean base-flow discharge, nutrient, and suspended-sediment loads transported by Sherman Creek at Shermans Dale, Pa., calendar years 1985-89

Month	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Ortho-phosphate as P	Total Phosphorus as P	Suspended Sediment
	cfs	thousands of pounds						
January	120	29.9	0.603	7.63	0.402	0.100	0.502	120
February	172	41.4	.650	5.72	.650	.078	.858	104
March	204	53.6	.512	9.22	.854	.102	.854	171
April	201	31.3	.651	10.7	.977	.130	1.30	195
May	167	23.2	.978	14.0	.699	.112	1.40	140
June	90	11.4	1.02	6.27	.583	.073	.729	219
July	48	5.78	.305	3.05	.321	.056	.482	80.4
August	32	2.30	.204	1.93	.187	.016	.321	32.1
September	50	7.29	.405	3.32	.284	.049	.446	72.9
October	51	7.60	.171	2.22	.188	.051	.256	51.2
November	120	21.8	.350	5.25	.486	.117	.778	97.2
December	181	50.6	.606	8.79	.667	.182	1.06	90.9
Annual	119	286	6.46	78.1	6.30	1.07	8.99	1,370

Conestoga River at Conestoga, Pa.

Concentrations of nutrients in the Conestoga River changed during May 1988. A summary of the concentrations of nutrients and suspended sediment in samples collected during periods of base flow from January 1985 through May 1988 given in table 10, and a summary of the base-flow loads of suspended sediment and nutrients for the same period is given in table 11. The base-flow loads of nutrients and suspended sediments were calculated using solely base-flow discharges for the respective sampling periods. A summary of the concentrations in base-flow samples collected from June 1988 through December 1989 given in table 12, and a summary of the base-flow loads for the same period is given in table 13. The change in base-flow concentrations occurred when a sewage treatment plant in Lancaster was upgraded to provide for reductions in ammonia and phosphorus. Total ammonia concentrations changed the most. From January 1985 through May 1988, the concentrations of ammonia in the base flow averaged 0.29 mg/; after May 1988, the concentrations of ammonia in the base flow averaged 0.06 mg/l, representing a decrease of about 79 percent.

Concentrations of total organic nitrogen, and dissolved orthophosphate, and total phosphorus were lower in samples of base flow collected after May 1988 than in earlier samples. Total organic nitrogen concentrations decreased from an average of 0.81 to an average of 0.53 mg/l, a reduction of 35 percent; dissolved phosphorus concentrations decreased from an average of 0.30 to 0.18 mg/l, a reduction of 40 percent; orthophosphate concentrations decreased from a average of 0.23 to 0.13 mg/l, a reduction of 43 percent; and total phosphorus concentrations decreased from an average of 0.37 to 0.22 mg/l, a reduction of 40 percent. Values of monthly mean base-flow discharges and nitrite plus nitrate concentrations are plotted in figure 5 for the periods

TABLE 10.--Monthly mean base-flow discharge and corresponding monthly mean concentrations of nutrients and suspended sediment transported by Conestoga River at Conestoga, Pa., January 1985-May 1988

Month	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Ortho-phosphate as P	Total Phosphorus as P	Suspended Sediment
	cfs	mg/l						
January	355	8.90	0.65	0.85	0.23	0.15	0.30	6
February	535	8.00	.60	.85	.23	.22	.25	34
March	555	8.60	.34	.70	.18	.10	.23	20
April	482	7.80	.32	1.10	.18	.15	.23	20
May	370	7.70	.23	1.05	.23	.22	.25	23
June	325	7.40	.11	.65	.30	.33	.40	45
July	248	7.40	.06	.80	.42	.37	.55	52
August	218	5.80	.13	.90	.48	.30	.55	26
September	211	7.00	.08	.70	.40	.23	.50	17
October	255	8.20	.17	.80	.36	.32	.48	14
November	326	8.00	.30	.70	.36	.26	.45	14
December	375	8.80	.50	.65	.25	.07	.28	7

TABLE 11.--Monthly and annual mean base-flow discharge, nutrient, and suspended-sediment loads transported by the Conestoga River at Conestoga, Pa., January 1985-May 1988

	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Ortho-phosphate as P	Total Phosphorus as P	Suspended Sediment
Month	cfs	thousands of pounds						
January	355	529	38.6	50.5	13.7	8.91	17.8	356
February	535	647	48.5	68.8	18.6	17.8	20.2	2,750
March	555	799	31.6	65.0	16.7	9.29	21.4	1,800
April	482	609	25.0	85.9	14.1	11.7	18.0	1,560
May	370	477	14.3	65.0	14.2	13.6	15.5	1,420
June	325	390	5.79	34.2	15.8	17.4	21.1	2,370
July	248	300	2.49	32.1	16.9	14.9	22.1	2,160
August	218	212	4.74	32.8	17.5	10.9	20.1	947
September	211	239	2.74	23.9	13.7	7.86	17.1	580
October	255	350	7.26	34.1	15.4	13.7	20.5	597
November	326	422	15.8	37.0	19.0	13.7	23.8	739
December	375	552	31.4	40.8	15.7	4.39	17.6	439
Annual	353	5,530	228	570	191	144	235	15,700

TABLE 12.--Monthly mean base-flow discharge and corresponding monthly mean concentrations of nutrients and suspended sediment transported by Conestoga River at Conestoga, Pa., June 1988-December 1989

Month	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Ortho-phosphate as P	Total Phosphorus as P	Suspended Sediment
	cfs	mg/l						
January	344	8.00	0.05	0.30	0.15	0.13	0.18	6
February	518	8.20	.07	.35	.14	.07	.18	28
March	580	8.60	.04	.50	.14	.09	.21	40
April	506	8.40	.02	.50	.12	.10	.16	25
May	377	8.40	.04	.40	.13	.05	.16	28
June	326	8.50	.04	.90	.13	.11	.27	46
July	270	7.40	.03	1.00	.17	.10	.27	46
August	311	9.50	.05	.40	.24	.21	.30	32
September	259	8.60	.06	.70	.24	.20	.27	25
October	253	8.20	.10	.55	.26	.20	.27	11
November	337	6.90	.09	.40	.20	.15	.23	18
December	378	9.20	.09	.40	.18	.15	.20	6

TABLE 13.--Monthly and annual mean base-flow discharge, nutrient, and suspended-sediment loads transported by the Conestoga River at Conestoga, Pa., June 1988-December 1989

Month	Base-flow Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Ortho-phosphate as P	Total Phosphorus as P	Suspended Sediment
	cfs	thousands of pounds						
January	344	461	2.88	17.3	8.64	7.49	10.4	346
February	518	642	5.48	27.4	11.0	5.48	14.1	2,190
March	580	835	3.88	48.5	13.6	8.74	20.4	3,880
April	506	689	1.64	41.0	9.84	8.20	13.1	2,050
May	377	530	2.52	25.2	8.20	3.16	10.1	1,770
June	326	449	2.11	47.5	6.86	5.81	14.3	2,430
July	270	334	1.36	45.2	7.68	4.52	12.2	2,080
August	311	494	2.60	20.8	12.5	10.9	15.6	1,660
September	259	361	2.52	29.4	10.1	8.39	11.3	1,050
October	253	347	4.24	23.3	11.0	8.47	11.4	466
November	337	377	4.91	21.8	10.9	8.19	12.6	983
December	378	584	5.71	25.4	11.4	9.52	12.7	381
Annual	372	6,100	39.8	373	122	88.9	158	19,300

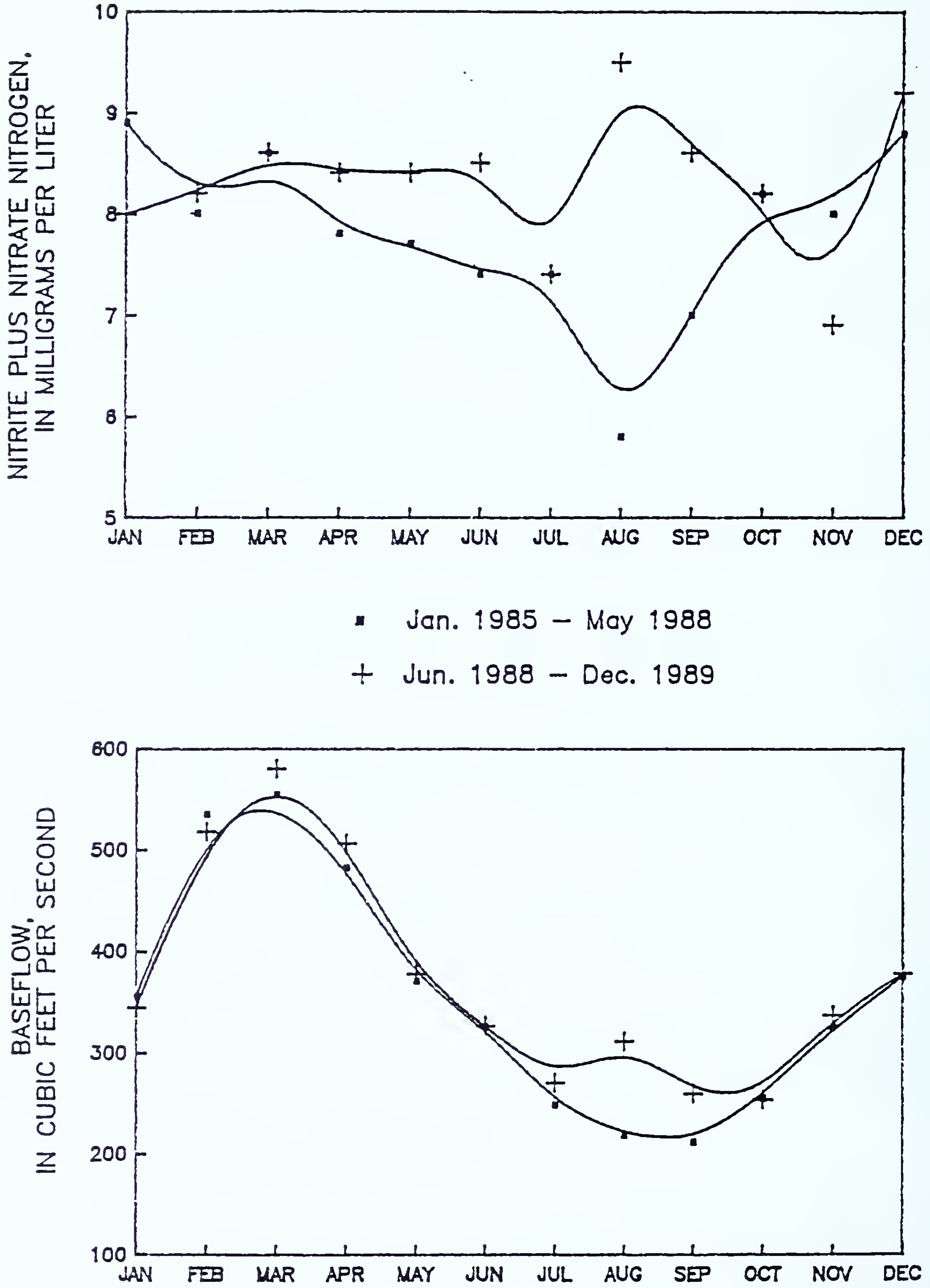


FIGURE 5.--Monthly mean base flow and nitrite plus nitrate nitrogen concentrations, Conestoga River at Conestoga, Pa., January 1985-May 1988 and June 1988-December 1989

January 1985-May 1988 and June 1988-December 1989. Total nitrite plus nitrate concentrations during base-flow periods appeared to increase. The average concentration in samples of base flow collected from January 1985 through May 1988 was 7.80 mg/l, and the average concentration after May 1988 was 8.32 mg/l, for an increase of 7 percent.

Seasonal variation was noted in the concentrations of nutrients and suspended sediment in the base-flow samples collected from the Conestoga River. During the period from January 1985 through May 1988, total ammonia concentrations averaged 0.09 mg/l during summer and 0.53 mg/l during winter. After May 1988, the concentrations of total ammonia averaged 0.05 mg/l during summer and 0.05 mg/l during winter. From January 1985 through May 1988, total phosphorus concentrations averaged 0.53 mg/l in summer and 0.26 mg/l during winter. After May 1988, the concentration of total phosphorus averaged 0.28 mg/l during summer and 0.19 mg/l during winter. Suspended-sediment concentrations during base-flow periods were not affected by the improvements to the sewage-treatment plant; they averaged 23 mg/l from January 1985 through May 1988, and 26 mg/l after May 1988. For the entire 5-year period, suspended-sediment concentrations in base flow averaged 22 mg/l during winter and 33 mg/l during summer.

Loads of nutrients transported by the Conestoga River during periods of base flow also changed in 1988. From January 1985 through May 1988, the annual base-flow load of total ammonia was 228,000 pounds; after May 1988, the annual base-flow load was 39,800 pounds, representing a decrease of 83 percent. Annual loads of total ammonia decreased 188,000 pounds and annual loads of total organic nitrogen decreased by 197,000 pound;, however, annual loads of total nitrite plus nitrate increased by 570,000 pounds. The apparent net increase in base-flow total nitrogen loads is 185,000 pounds, for an increase of 2.9 percent.

Base-flow loads of dissolved orthophosphate and total phosphorus also decreased after May 1988. Dissolved phosphorus loads decreased 69,000 pounds, orthophosphate decreased 55,000 pounds, and total phosphorus loads decreased 77,000 pounds annually after May 1988.

The mean water discharge of base flows was 353 cfs in the period January 1985 through May 1988, and it was 372 cfs after May 1988; these flows are 60 and 63 percent, respectively, of the long-term mean of 587 cfs. Although base flow represented 62 percent of the average water discharged from January 1985 to December 1987, the annual nitrite plus nitrate load transported by base flow for this same period was 5,530,000 lbs/yr, or 73 percent of the total annual load.

The base-flow load of total ammonia calculated from the data collected from January 1985 through May 1988 averaged 228,100 lbs/yr, which was 41 percent of the total annual load of ammonia for the period. The base-flow load of total ammonia calculated from the data collected after May 1988 averaged 39,800 lbs/yr, or 21 percent of the total annual load. Loads of total nitrogen transported by base flow in the two periods were 63 and 48 percent, respectively, of the gross annual total nitrogen loads. The loads of total phosphorus transported by base flow were 34 and 20 percent of the gross annual total phosphorus loads transported during the periods January 1985 through December 1987 and calendar year 1989, respectively.

Base-flow highlights for the three sampling sites are as follows. Base flow for the Susquehanna River at Danville accounts for approximately 60 percent of the total streamflow. Base flow carries half of the annual TN load and approximately one-third of the TP load. Inorganic nitrogen makes up two-thirds of the TN load. Total nitrogen concentrations are lowest in summer and highest in winter, while TP concentrations are lowest in fall and highest in summer.

Base flow for Sherman Creek at Shermans Dale comprises slightly less than 50 percent of the total streamflow. Base flow carries approximately one-third of the annual TN load and one-sixth of the TP load. Inorganic nitrogen makes up less than 10 percent of the TN. Total nitrogen concentration are lowest in summer and highest in winter, while TP concentrations are lowest in winter and highest in summer.

Base flow for the Conestoga River at Conestoga accounts for approximately 60 percent of the total streamflow. Base flow carries 60 percent of the annual TN load and approximately 30 percent of the TP load. Inorganic nitrogen comprises 90 percent of the TN load. Total nitrogen concentrations are lowest in summer and highest in winter, while TP concentrations are lowest in winter and highest in summer.

STORMFLOW NUTRIENT AND SUSPENDED-SEDIMENT CONCENTRATIONS

Statistics (maximums, minimums, and means) of stormflow data collected at all sites are also summarized by season and period-of-record in Appendix B.

Concentrations of nutrients and suspended sediment can change rapidly as water discharge changes during storms. The patterns of variation in these concentrations can differ for similar-sized storms that occur just a few days apart; also, there can be seasonal differences. The variabilities in constituent concentrations dictates the number of samples needed to compute loads of a selected accuracy. The greater the variation in nutrient and suspended-sediment concentrations, the larger the number samples required to compute the loads. This variability in stormflow constituent concentrations is apparent when looking at data collected during stormflow at the same three sites that were discussed for base-flow conditions--the Susquehanna River at Danville, Sherman Creek at Shermans Dale, and the Conestoga River at Conestoga.

Seasonal graphs of stormflow concentrations were plotted. Concentrations for the samples were plotted against the difference between times of sampling and the times of peak flow. Nutrient and sediment concentrations in samples collected at the time of peak flow were plotted at a time difference of zero. The resultant seasonal hydrographs of concentration and flow were used to determine average water discharge and average nutrient and suspended-sediment concentrations for selected intervals before, at, and after peak flows. For Danville, concentrations were determined from 4 days before peak flow to 7 days after. For Shermans Dale and Conestoga, concentrations were determined from 24 hours before peak flow to 48 hours after.

Susquehanna River at Danville, Pa.

The Susquehanna River at Danville was sampled during 13 storms, three during winter, seven during spring, one during summer, and two during fall. Daily water discharges and the mean concentrations of suspended sediment, ammonia, nitrite plus nitrate, total organic nitrogen, dissolved phosphorus, and total phosphorus are given in tables 14 through 17 for the four calendar quarters, respectively.

The mean high-water discharge of the Susquehanna River at Danville was 130,000 cfs for the three storms sampled during winter (table 14). Flow in the river averaged 25,000 cfs at 4 days before the peaks; it decreased to 32,000 cfs at 7 days after the peaks.

The mean concentration of nitrite plus nitrate decreased from 1.10 mg/l at 4 days before the peak water discharge to 0.88 mg/l at 1 to 2 days after the peak flow; it then increased to 1.12 mg/l at 7 days after the peak flow.

TABLE 14.--Daily water discharge and average nutrient and suspended-sediment concentrations during winter storms, Susquehanna River at Danville, Pa., calendar years 1985-89

Days Before (-) After (+) Peak Water Discharge	Daily Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs				mg/l		
-4	25,000	1.10	0.08	0.78	0.045	0.09	20
-3	35,000	1.10	.08	.85	.045	.09	70
-2	45,000	1.10	.09	1.18	.045	.10	140
-1	80,000	1.08	.08	1.60	.035	.20	550
0	130,000	.93	.10	1.30	.045	.19	500
+1	100,000	.88	.11	1.08	.045	.15	360
+2	75,000	.88	.11	.94	.045	.12	150
+3	60,000	.93	.12	.70	.035	.10	100
+4	50,000	1.00	.13	.68	.030	.08	70
+5	43,000	1.05	.12	.60	.030	.07	40
+6	37,000	1.10	.13	.55	.030	.07	25
+7	32,000	1.12	.12	.45	.040	.07	15

TABLE 15.--Daily water discharge and average nutrient and suspended-sediment concentrations during spring storms, Susquehanna River at Danville, Pa., calendar years 1985-89

Days Before (-) After (+) Peak Water Discharge	Daily Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs				mg/l		
-4	20,000	0.72	0.06	0.40	0.025	0.09	20
-3	30,000	.72	.06	.60	.025	.09	45
-2	40,000	.72	.06	.90	.025	.09	120
-1	65,000	.72	.07	1.05	.030	.14	280
0	80,000	.71	.06	1.35	.045	.25	350
+1	68,000	.72	.07	1.18	.045	.19	190
+2	55,000	.74	.08	.94	.050	.15	110
+3	45,000	.76	.08	.75	.050	.14	65
+4	35,000	.78	.07	.60	.045	.14	50
+5	30,000	.80	.06	.55	.040	.13	30
+6	28,000	.80	.05	.50	.035	.13	33
+7	24,000	.80	.05	.50	.035	.11	20

TABLE 16.--Daily water discharge and average nutrient and suspended-sediment concentrations during summer storms, Susquehanna River at Danville, Pa., calendar years 1985-89

Days Before (-) After (+) Peak Water Discharge	Daily Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs				mg/l		
-2	5,000	0.82	0.10	0.85	0.02	0.11	30
-1	11,000	1.03	.10	.90	.03	.25	135
0	15,000	.96	.11	.90	.03	.25	83
+1	8,600	.85	.09	.60	.03	.18	53
+2	6,400	.85	.07	.52	.03	.14	29

TABLE 17.--Daily water discharge and average nutrient and suspended-sediment concentrations during fall storms, Susquehanna River at Danville, Pa., calendar years 1985-89

Days Before (-) After (+) Peak Water Discharge	Daily Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs				mg/l		
-4	7,000	1.00	.04	0.60	0.040	0.07	10
-3	11,000	1.05	.05	.60	.035	.07	40
-2	26,000	1.05	.09	.90	.030	.11	100
-1	33,500	.92	.07	.80	.030	.13	85
0	40,000	.88	.06	.65	.035	.12	80
+1	38,000	.84	.05	.60	.035	.09	70
+2	33,000	.78	.05	.55	.030	.08	45
+3	25,000	.80	.05	.70	.035	.08	40
+4	21,000	.84	.07	.80	.040	.08	30
+5	16,000	.90	.06	.90	.040	.08	20

Concentrations of ammonia were 0.08 mg/l at 4 days before the peak flow. They increased to 0.13 mg/l at 4 to 6 days after the peak flow. Concentrations of total organic nitrogen, total phosphorus, and suspended sediment increased as streamflow increased, peaked at about the same time as streamflow and decreased as streamflow decreased. The maximum concentrations of the three constituents were 1.60, 0.20, and 550 mg/l, respectively.

Daily mean water discharges at Danville, in the period from 4 days before the peak to 7 days after the peak of streamflow for the seven flood flows sampled during spring, are listed in table 15, along with the average daily concentrations of nutrients and suspended sediment. Water discharge averaged 20,000 cfs at 4 days before peak flow. The average peak flow of the seven storms was 80,000 cfs. The average water discharge of the seven storms was 24,000 cfs at 7 days after peak flow. Nitrite plus nitrate concentrations averaged 0.72 mg/l at 4 days before the peak flow, decreased slightly to 0.71 mg/l at the peak flow, and then increased to average 0.80 mg/l at 5-7 days after the peak flow.

Concentrations of ammonia in the Susquehanna River at Danville averaged 0.06 mg/l at the start of the storms, remained at about 0.06 mg/l until after the peak flow, and then increased to 0.08 mg/l at 2 days after the peak flow. Concentrations of ammonia declined to 0.05 mg/l at 7 days after the peak flow.

Concentrations of total organic nitrogen, total phosphorus, and suspended sediment increased as streamflow increased, peaked when flow peaked, and decreased as streamflow decreased. Concentrations of total organic nitrogen averaged 0.40 mg/l at the start of the storms, increased to 1.35 mg/l at the peak flow, and decreased to 0.50 mg/l at 7 days after the peak flow. Concentrations of total phosphorus increased from 0.09 mg/l at 4 days before the peak flow to 0.25 mg/l at the peak flow and decreased to 0.11 mg/l at

7 days after the peak flow. Daily suspended-sediment concentrations averaged 20 mg/l at 4 days before the peak flow, 350 mg/l at the time of peak flow, and then decreased to 20 mg/l at 7 days after the peak flow.

Data from flood flows sampled during summer are listed in table 16. The peak flow was 15,000 cfs and the peak suspended-sediment concentration was 135 mg/l. Ammonia concentrations were 0.10 mg/l while streamflow was increasing, 0.11 mg/l at peak flow, and 0.07 mg/l at 2 days after peak flow. The peak nitrite plus nitrate concentration was 1.03 mg/l; the peak concentration of total organic nitrogen was 0.90 mg/l; and the peak concentration of total phosphorus was 0.25 mg/l.

Two storms were sampled during fall (table 17). The peak water discharge of the Susquehanna River at Danville was 38,200 cfs for the first storm and 41,800 cfs for the second storm. The peak suspended-sediment concentration was 88 mg/l for the first storm and 122 mg/l for the second storm. The average daily nitrite plus nitrate concentration at 4 days before the peak flow was 1.00 mg/l; it increased to 1.05 mg/l before decreasing to 0.78 mg/l at 2 days after peak flow. The average concentration of nitrite plus nitrate was 0.90 mg/l at 5 days after peak flow.

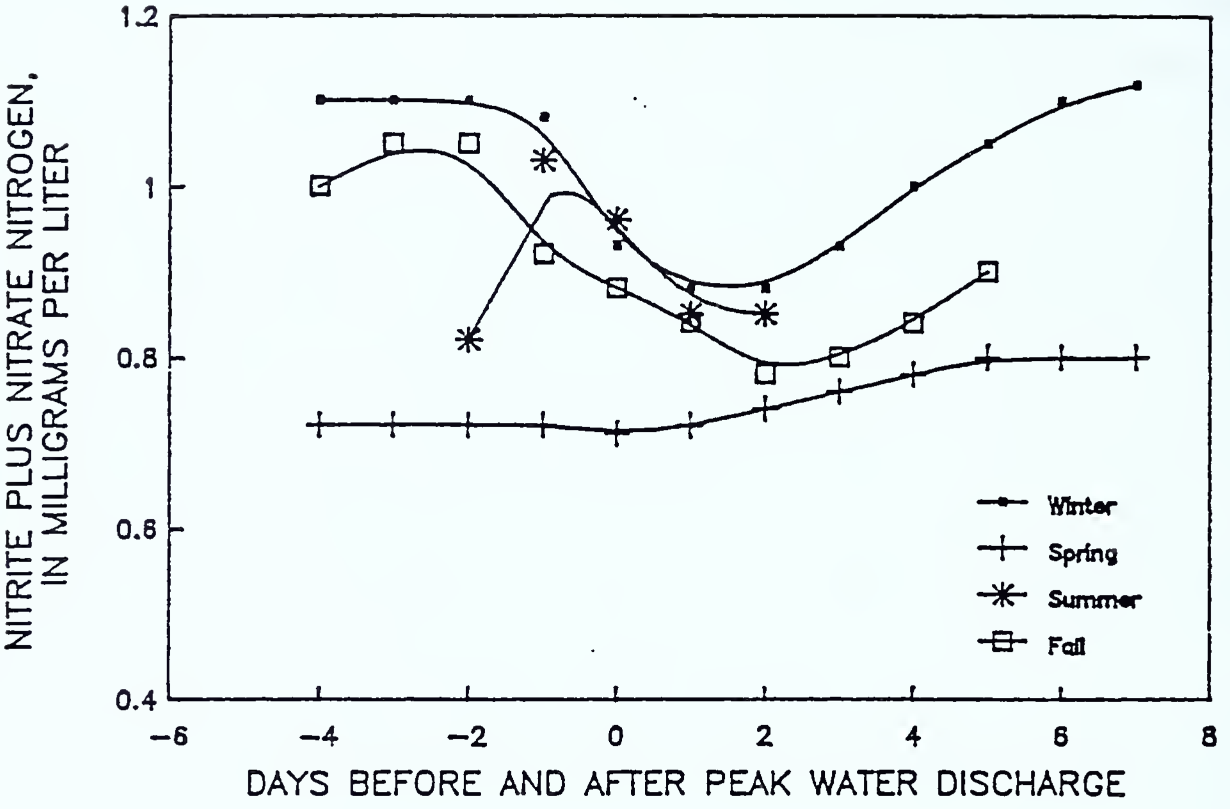
Ammonia concentrations in the river averaged 0.04 mg/l at the start of the storms. They increased to 0.09 mg/l at 2 days before peak flow, then decreased to 0.06 mg/l at peak flow, and remained at about 0.06 mg/l during the recession. Concentrations of total organic nitrogen ranged from 0.55 to 0.90 mg/l. They were 0.60 mg/l at the start of the storm and 0.90 mg/l at the end. Total phosphorus concentrations were 0.07 mg/l at the start of the storm; they increased to 0.13 mg/l at 1 day before peak flow, decreased to 0.08 mg/l at 2 days after peak flow, and remained at that level for the next 3 days.

Storm-water discharges and concentrations of nitrite plus nitrate are plotted for each season in figure 6. The discharge hydrographs show that winter storms had the highest flow. Summer storms caused the smallest seasonal rises in the Susquehanna River at Danville; however, nitrite plus nitrate concentrations were as high in summer as in winter and tended to increase with increasing flows. Nitrite plus nitrate concentrations for winter, spring, and fall storms generally decreased as water discharge increased, with the minimum concentration occurring after peak flows. The concentrations increased as water discharge decreased.

Sherman Creek at Shermans Dale, Pa.

Sherman Creek drains an area that is 24 percent agricultural and 70 percent forested. Very little urban area is in the basin (table 5). Data from storms sampled from 1985 through 1989 is summarized by seasons in tables 18 through 21. Average water discharges and mean concentrations of suspended sediment, ammonia, nitrite plus nitrate, total organic nitrogen, dissolved phosphorus, and total phosphorus are listed in the tables.

Three storms were sampled in winter, nine were sampled in spring, four were sampled in summer, and four were sampled in fall. Table 18 lists the mean values of water discharge, suspended sediment, and nutrients from the storms sampled in winter. The data is for the period from 24 hours before the time of peak flow to 48 hours after peak flow. Hourly average water discharge of the storms sampled during winter ranged from 400 cfs at 24 hours before the peak, to 1,450 cfs at peak flow, and decreased to 650 cfs at 48 hours after peak flow.



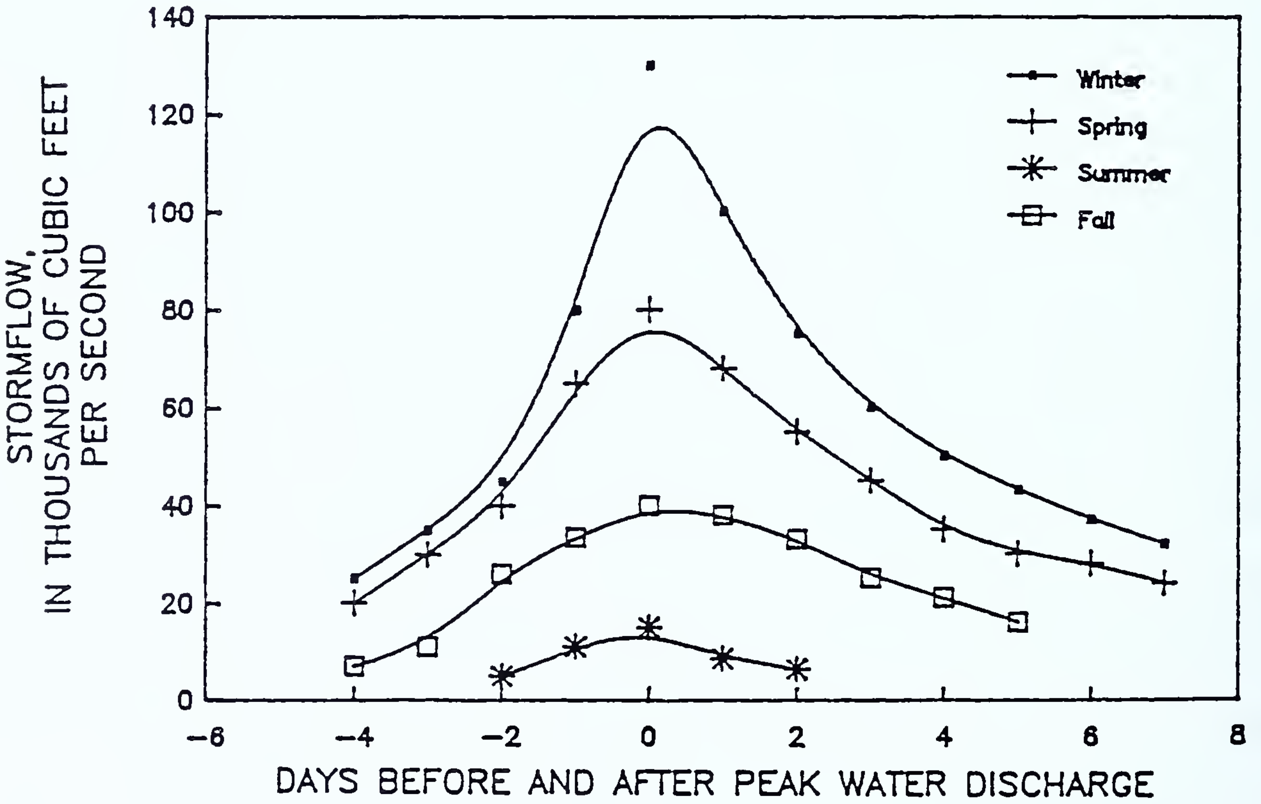


FIGURE 6.--Comparison of seasonal stormflow and average nitrite plus nitrate nitrogen concentrations, Susquehanna River at Danville, Pa., 1985-89

TABLE 18.--Hourly water discharge and average nutrient and suspended sediment concentrations during winter storms, Sherman Creek at Shermans Dale, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs	mg/l					
-24	400	1.60	0.04	0.30	0.04	0.05	10
-21	500	1.60	.05	.30	.04	.06	20
-18	600	1.70	.05	.40	.04	.06	30
-15	700	1.80	.06	.40	.04	.07	40
-12	800	1.80	.07	.40	.05	.07	55
-9	950	1.90	.08	.50	.05	.08	60
-6	1,100	2.00	.10	.60	.05	.10	70
-4	1,250	2.00	.11	.70	.05	.13	70
-2	1,400	2.10	.12	.70	.05	.13	70
0	1,450	2.10	.12	.60	.06	.10	60
+2	1,400	2.10	.10	.50	.05	.09	55
+4	1,340	2.10	.08	.50	.05	.08	50
+6	1,280	2.00	.08	.50	.05	.08	45
+9	1,230	2.00	.07	.50	.04	.07	45
+12	1,170	2.00	.07	.50	.04	.07	40
+15	1,100	2.00	.06	.50	.04	.06	40
+18	1,030	2.00	.06	.50	.04	.06	35
+24	980	2.00	.05	.50	.04	.05	35
+30	920	2.00	.05	.50	.04	.05	30
+36	850	2.00	.05	.50	.04	.05	30
+42	750	2.00	.04	.50	.04	.05	25
+48	650	2.00	.04	.50	.04	.05	25

TABLE 19.--Hourly water discharge and average nutrient and suspended-sediment concentrations during spring storms, Sherman Creek at Shermans Dale, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs	mg/l					
-24	350	1.00	0.04	0.50	0.03	0.09	30
-21	450	1.10	.05	.55	.03	.10	35
-18	600	1.10	.06	.60	.04	.12	40
-15	800	1.10	.06	.65	.05	.14	50
-12	1,000	1.20	.07	.70	.05	.18	70
-9	2,200	1.20	.08	.90	.06	.21	100
-6	2,800	1.20	.09	1.10	.06	.24	160
-4	3,200	1.20	.10	1.30	.07	.27	300
-2	3,400	1.30	.12	1.40	.07	.29	400
0	3,600	1.30	.11	1.50	.08	.27	500
+2	3,500	1.30	.10	1.40	.07	.25	300
+4	3,350	1.30	.10	1.30	.07	.22	250
+6	3,200	1.30	.10	1.10	.06	.20	200
+9	2,950	1.40	.09	.90	.06	.18	140
+12	2,700	1.40	.09	.80	.05	.15	100
+15	2,200	1.40	.08	.80	.05	.13	75
+18	1,700	1.40	.07	.70	.04	.12	60
+24	1,300	1.40	.07	.70	.04	.10	50
+30	1,250	1.40	.06	.60	.04	.08	45
+36	1,200	1.50	.05	.60	.04	.07	40
+42	1,150	1.50	.04	.50	.03	.06	35
+48	1,100	1.50	.04	.50	.03	.06	30

TABLE 20.--Hourly water discharge and average nutrient and
concentrations during summer storms, Sherman Creek at Shermans Dale, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs				mg/l		
-24	50	0.75	0.04	0.40	0.04	0.06	6
-21	70	.75	.05	.40	.04	.06	6
-18	100	.80	.06	.45	.04	.07	8
-15	140	.85	.06	.50	.04	.12	15
-12	200	.85	.08	.60	.04	.15	40
-9	800	.90	.10	.65	.05	.20	70
-6	1,400	1.05	.15	.70	.06	.28	180
-4	1,800	1.15	.18	.75	.07	.33	300
-2	2,500	1.20	.18	.75	.08	.33	280
0	2,680	1.30	.16	.70	.09	.30	260
+2	2,640	1.30	.13	.65	.09	.28	240
+4	2,550	1.35	.10	.65	.09	.24	220
+6	2,450	1.40	.09	.60	.08	.21	200
+9	2,200	1.50	.09	.60	.08	.18	150
+12	1,750	1.60	.08	.60	.07	.15	110
+15	1,400	1.70	.08	.55	.07	.12	70
+18	1,100	1.80	.07	.55	.07	.10	40
+24	900	1.90	.07	.50	.06	.08	25
+30	800	1.90	.06	.50	.06	.07	21
+36	720	1.90	.06	.45	.06	.07	18
+42	650	1.90	.06	.45	.05	.06	18
+48	600	1.90	.06	.40	.05	.06	18

TABLE 21.--Hourly water discharge and average nutrient and suspended-sediment concentrations during fall storms, Sherman Creek at Shermans Dale, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N	Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
	cfs	mg/l					
-24	380	1.40	0.04	0.55	0.03	0.06	10
-21	420	1.40	.05	.55	.03	.06	20
-18	460	1.40	.05	.55	.03	.07	30
-15	520	1.40	.05	.60	.04	.07	45
-12	600	1.40	.06	.60	.04	.08	80
-9	700	1.40	.06	.60	.05	.14	100
-6	800	1.50	.07	.65	.05	.18	130
-4	1,000	1.50	.07	.70	.05	.20	150
-2	1,050	1.60	.08	1.20	.05	.20	210
0	1,100	1.60	.08	1.30	.05	.20	300
+2	1,050	1.70	.08	1.20	.05	.19	280
+4	1,000	1.70	.08	1.00	.05	.17	260
+6	940	1.80	.09	.95	.05	.15	230
+9	780	1.90	.08	.85	.05	.13	170
+12	660	1.90	.07	.80	.05	.12	95
+15	600	1.80	.06	.75	.05	.10	60
+18	520	1.80	.05	.70	.04	.09	35
+24	460	1.80	.05	.60	.04	.08	17
+30	410	1.80	.05	.55	.04	.07	16
+36	370	1.70	.05	.55	.04	.06	15
+42	330	1.70	.04	.50	.03	.06	14
+48	280	1.70	.04	.50	.03	.05	13

Suspended-sediment concentrations averaged 10 mg/l near the start of the storms, increased to 70 mg/l at 6 hours before the time of peak streamflow, and then declined to about 25 mg/l at 48 hours after the peak. Concentrations of total ammonia, total organic nitrogen, nitrite plus nitrate, dissolved phosphorus, and total phosphorus also varied during the storms, but over a much smaller range. Total ammonia ranged from 0.04 mg/l to 0.12 mg/l and total organic nitrogen ranged from 0.30 to 0.70 mg/l. Minimum concentrations of total ammonia and total organic nitrogen generally occurred at the beginning of a storm and maximum concentrations generally occurred near the time of peak streamflow. Total nitrite plus nitrate ranged from 1.60 mg/l at the beginning of storms to 2.1 mg/l at the time of peak flow; it declined to 2.0 mg/l by 48 hours after the time of peak flow. The increase in concentrations of nitrite plus nitrate is the opposite of the relation observed in the Susquehanna River at Danville, where concentrations declined as streamflow increased and minimum concentrations occurred at the time of maximum water discharge. Concentrations of total nitrogen, not listed on table 18, ranged from 1.94 mg/l at the start of the storms, to 2.82 mg/l at the time of peak flow. They declined slowly to 2.55 mg/l at 24 hours after the time of the peak flow.

Dissolved phosphorus concentrations in Sherman Creek varied only slightly during the winter storms. Average concentrations for the three storms ranged from about 0.04 mg/l at 24 hours before the peak flow to 0.06 mg/l at the time of peak flow. Concentrations returned to 0.04 mg/l at 48 hours after peak flow. Concentrations of total phosphorus increased from 0.05 mg/l near the start of the storm to 0.13 mg/l at 4 hours before the time of peak flow and decreased to 0.05 mg/l at 48 hours after peak flow. The maximum concentration of total phosphorus in any storm flows that were sampled during winter was 0.20 mg/l.

Table 19 lists the average hourly values of water discharge and concentrations of suspended sediment and nutrients for the nine springtime storms sampled from 1985 through 1989 at Sherman Creek. The average peak discharge from the nine storms was 3,600 cfs. Peak discharge for six of the nine storms ranged from 2,220 to 3,970 cfs; one had a peak flow of 11,900 cfs, and two had peak discharges less than 1,600 cfs. Average streamflow at the start of the storms was 350 cfs and 48 hours after the peak discharge the flow was 1,100 cfs. Suspended-sediment concentrations ranged from about 30 mg/l at 24 hours before the time of peak flow to 500 mg/l at the time of peak flow. They then decreased to 30 mg/l at 48 hours after the peak. The maximum observed suspended-sediment concentration was 1,530 mg/l at 2 hours before the time of peak flow for the storm of June 21, 1989. By the time of peak flow the suspended-sediment concentration had declined to 1,220 mg/l, and by 2 hours after the time of peak flow the suspended-sediment concentration had declined to 690 mg/l.

Average total ammonia concentrations in storm flows sampled in spring increased from 0.04 mg/l at the start of the storms to 0.12 mg/l at 2 hours before the time of peak flow, and then decreased to 0.04 mg/l at 4 hours after the peak flow. The maximum observed concentration was 0.25 mg/l for the storm of April 1, 1987. Average total organic nitrogen concentrations for the nine storms increased from 0.50 mg/l at the start to 1.5 mg/l at the time of peak flow, and then decreased to 0.50 mg/l at 48 hours after peak flow. The maximum concentration of total organic nitrogen, which occurred during the storm of June 21, 1989 was 4.7 mg/l at 2 hours before the peak flow. The concentration declined from 4.0 mg/l at the time of peak flow to 2.9 mg/l at 2 hours after peak flow. Maximum concentrations of total organic nitrogen were below 1.8 mg/l for all other storms.

Average nitrite plus nitrate concentrations during the nine storms increased from 1.00 mg/l at the start of the storms to 1.30 mg/l at the time of peak flow, and then declined to 1.5 mg/l at 48 hours after peak flow. During the large storm of June 21, 1989, nitrite plus nitrate concentrations were 1.56, 1.36, and 1.14 mg/l at 2 hours before peak flow, and on the peak and at 2 hours after peak flow. By 48 hours after the time of peak flow on June 23, 1989, the concentration had increased to 1.68 mg/l. Water discharge was then about 2,200 cfs.

Average total nitrogen concentrations increased from 1.54 mg/l at the start of the storms to 2.91 mg/l at the time of peak flow, and then decreased to 2.04 mg/l at 48 hours after peak flow. Dissolved phosphorus concentrations increased from 0.03 mg/l at the start of the storms to 0.08 mg/l at the time of peak flow, and decreased to 0.03 mg/l at 48 hours later. The maximum measured concentration of dissolved phosphorus was 0.12 mg/l during the storm that occurred on April 1, 1987. Average total phosphorus concentrations ranged from 0.09 mg/l at the start of the storms to 0.29 mg/l at 2 hours before the time of peak flow; they then declined to 0.06 mg/l at 48 hours later. The maximum concentration of total phosphorus was 1.7 mg/l during the storm that occurred on June 21, 1989.

Table 20 lists the average hourly values of water discharge, and concentrations of suspended sediment and nutrients, for four summer storm flows of Sherman Creek. Peak flows of the four storms were 135, 850, 2,680, and 7,070 cfs, for an average of 2,680 cfs. Suspended-sediment concentrations increased from 6 mg/l at the start of the storms to 300 mg/l at 4 hours before the time of peak flow, and then decreased to 18 mg/l at 48 hours after peak flow. Total ammonia concentrations increased from 0.04 mg/l at the start of the storms to 0.18 mg/l at the time of peak flow, and fell back to 0.06 mg/l at 48 hours after peak flow. Total organic nitrogen concentrations increased from 0.40 mg/l at the start of the storms to 0.75 mg/l at the time of peak flow, and then declined to 0.40 mg/l at 48 hours later. Total nitrite plus nitrate concentrations increased from 0.75 mg/l at the start of the storms to 1.30 mg/l at the time of peak flow, and then increased to 1.90 mg/l at 48 hours later. Dissolved phosphorus concentrations increased from 0.04 mg/l at the start of the storms to 0.09 mg/l at the time of peak flow, and then declined to 0.05 mg/l at 48 hours later. Total phosphorus concentrations increased from 0.06 mg/l at the start of the storms to 0.33 mg/l for 2 to 4 hours before the time of peak flow, and then returned to 0.06 mg/l at 48 hours after peak flow.

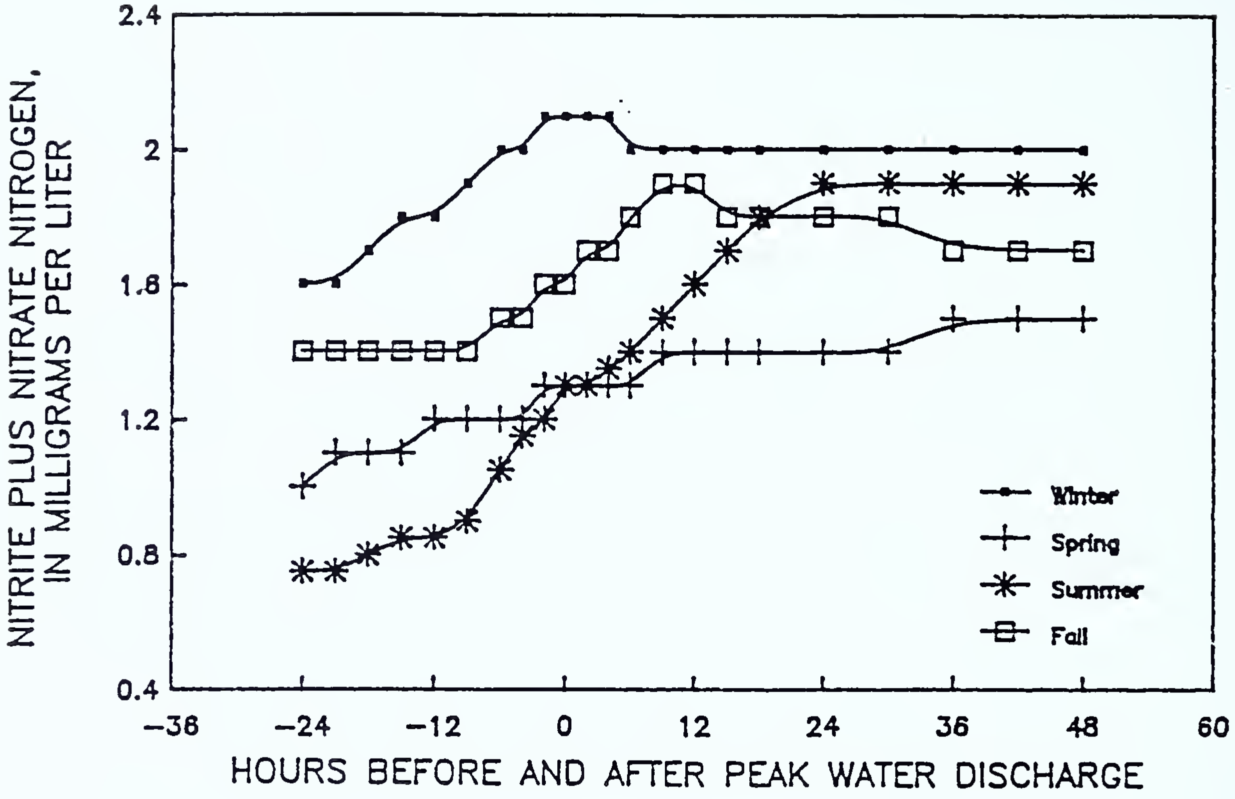
Table 21 lists the average hourly values of water discharge, and concentrations suspended sediment and nutrients, for four fall storms sampled from 1985 through 1989. The average peak flow was 1,100 cfs. Suspended-sediment concentrations increased from an average of 10 mg/l at the start of the storms to 300 mg/l at the time of peak flow, and then decreased to 13 mg/l at 48 hours later. Total ammonia increased from 0.04 mg/l at the start of the storms to 0.09 mg/l at 6 hours after the time of peak flow, and then declined to 0.04 mg/l at 48 hours later. Total organic nitrogen concentrations increased from 0.55 mg/l at the start of the storms to 1.30 mg/l at the time of peak flow, and then decreased to 0.50 mg/l at 48 hours after the peak. Total nitrite plus nitrate concentrations increased from 1.40 mg/l at the start of the storms to 1.60 mg/l at the time of the peak flow. Concentrations increased to 1.90 mg/l at 9 hours after peak flow, and then decreased to 1.70 mg/l at 48 hours after peak flow. Total nitrogen concentrations increased from 1.99 mg/l at the start of the storms to 2.98 mg/l at the time of peak flow, and then decreased to 2.24 mg/l at 48 hours after peak flow.

Dissolved phosphorus concentrations increased from 0.03 mg/l at the start of the storms to 0.05 mg/l at the time of peak flow, and then declined to 0.03 mg/l at 48 hours later. Total phosphorus concentrations increased from 0.06 mg/l at the start of the storms to 0.20 mg/l at the time of peak flow, and decreased to 0.05 mg/l at 48 hours later.

Plots of seasonal storm-water discharge and nitrite plus nitrate concentrations for Sherman Creek (figure 7) differ from those for the Susquehanna River at Danville. Spring storms had the highest water discharges, which was followed by the summer storms; winter and fall had the lowest flows. However, winter storms had the highest concentrations of nitrite plus nitrate; fall and summer storms had lower concentrations, and the spring storms had the lowest concentrations. The concentrations increased with increasing water discharge and they continued to increased for several hours after peak flow; then they remained generally constant during the remainder of the recession hydrograph for all seasons. This contrasts with the response at Danville.

Conestoga River at Conestoga, Pa.

An automatic pumping sampler was installed at Conestoga to collect samples from the Conestoga River. Samples were collected during 29 storms. Six of the storms occurred during winter, eight during spring, ten in summer, and five during fall. In May 1988, a new sewage-treatment plant went into operation at Lancaster. Seventeen storms were sampled before the plant went into operation and 12 were sampled after. Of the 12 storms sampled after the treatment plant went into operation, one occurred during winter, four occurred during spring, four occurred during summer, and three occurred during fall. The average water discharge and mean concentrations of nutrients and suspended



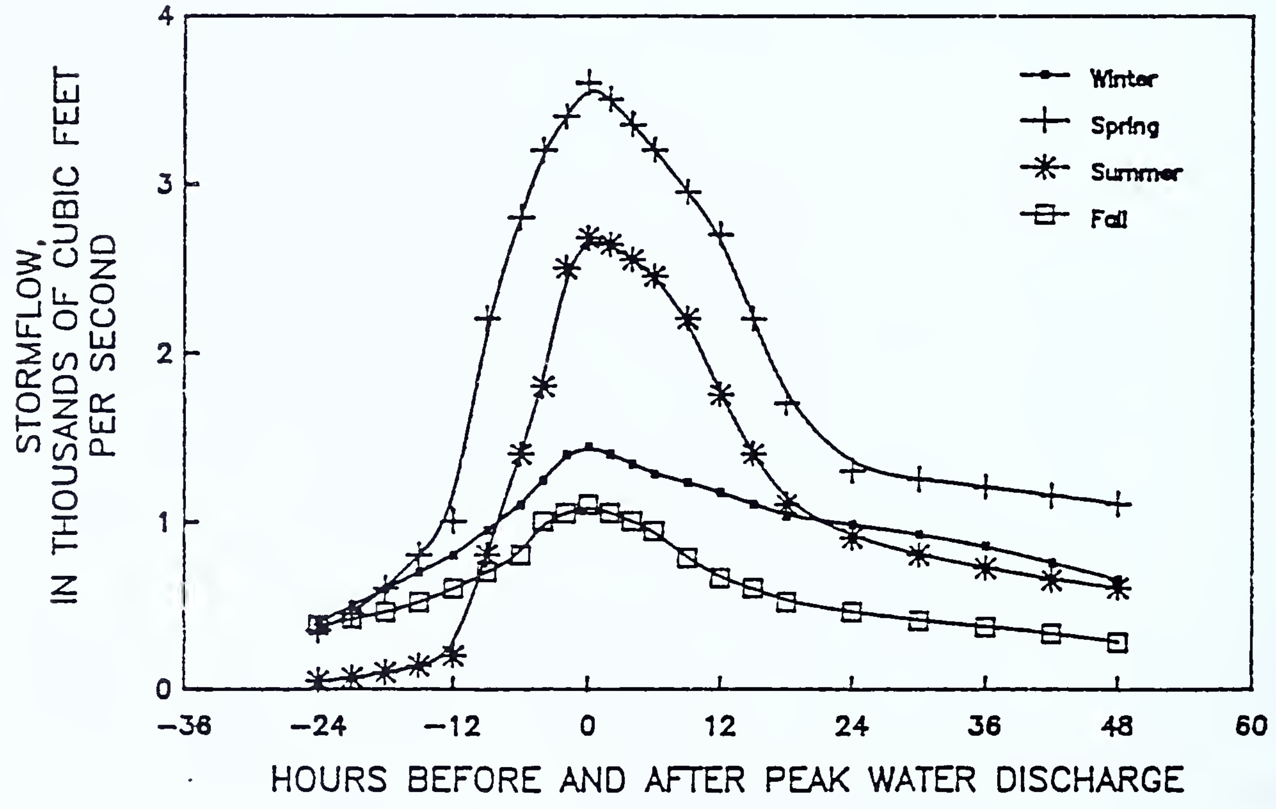


FIGURE 7.--Comparison of seasonal stormflow and average nitrite plus nitrate nitrogen concentrations, Sherman Creek at Shermans Dale, Pa., 1985-89

sediment that were determined for each of the seasonal storms are listed in tables 22 through 25. Each table has two columns under the total ammonia heading--one is for mean average concentrations from data collected before the treatment plant went into operation and the other is for mean hourly values from data collected after the plant went into operation. All other data on the tables are hourly averages determined from graphs of sample data. The largest storm flow sampled at Conestoga occurred on September 9, 1987; the peak flow was 19,000 cfs, which was about equivalent to a ten-year flood in the lower reaches of the Conestoga River.

Water discharges (plotted in figure 8) show that storms sampled during winter and fall tended to be smaller than those sampled during spring and summer. Averaged peak water discharge of storms sampled during winter and fall was 4,450 cfs; average peak flow of the storms sampled during spring and summer was 8,750 cfs. However, the highest concentrations of nitrite plus nitrate occurred during the winter storms; concentrations during spring storms were intermediate; and the lowest concentrations occurred during summer storms, which had the highest flows.

Time plots of average nitrite plus nitrate concentrations for the seasonal storms (figure 8) show an inverse relation to water discharge. Ammonia concentrations underwent little variation throughout the storms sampled before the sewage-treatment plant was upgraded. Ammonia concentrations in the Conestoga River were significantly lower and more variable during storms sampled after the sewage plant went into operation. Ammonia concentrations at the time of peak flow decreased after May 1988 as follows: from 0.6 to 0.08 mg/l for winter storms, from 0.32 to 0.26 mg/l for spring storms, from 0.34 to 0.10 mg/l for summer storms, and from 0.22 to 0.12 mg/l for fall storms. Spring storms had high concentrations when

TABLE 22.--Hourly water discharge and average nutrient and suspended-sediment concentrations during winter storms, Conestoga River at Conestoga, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N		Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
			Before May 1988	After May 1988				
	cfs	mg/l						
-24	600	8.50	0.75	0.11	1.00	0.20	0.36	100
-21	700	8.50	.74	.11	1.20	.20	.40	120
-18	850	8.60	.74	10	1.30	.20	.44	150
-15	1,100	8.70	.73	.10	1.40	.20	.47	175
-12	1,400	8.80	.72	.10	1.60	.20	.52	200
-9	1,800	8.40	.69	.09	1.80	.23	.98	300
-6	2,700	7.90	.66	.07	2.00	.25	1.40	400
-3	3,800	7.40	.63	.08	2.30	.22	1.50	740
0	4,500	6.80	.60	.08	2.50	.20	1.30	950
+3	4,000	6.00	.65	.07	2.40	.23	1.50	870
+6	3,400	5.30	.71	.08	2.30	.25	1.30	650
+9	2,800	4.60	.74	.23	2.20	.29	1.20	500
+12	2,400	4.00	.76	.44	2.10	.32	1.10	380
+15	2,000	4.00	.76	.45	2.10	.31	1.00	340
+18	1,800	4.30	.74	.45	2.00	.31	.90	310
+21	1,600	4.60	.72	.42	2.00	.30	.80	280
+24	1,500	4.90	.70	.40	1.90	.30	.70	250
+27	1,400	5.20	.68	.38	1.90	.30	.66	210
+30	1,300	5.50	.66	.36	1.90	.29	.62	180
+36	1,100	6.20	.62	.28	1.80	.28	.54	120
+42	1,050	6.80	.58	.26	1.70	.27	.49	105
+48	1,000	7.50	.56	.22	1.60	.26	.45	90

TABLE 23.--Hourly water discharge and average nutrient and suspended-sediment concentrations during spring storms, Conestoga River at Conestoga, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N		Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
			Before	After				
			May 1988					
	cfs	mg/l						
-24	1,000	7.00	0.28	0.30	1.50	0.17	0.30	40
-21	1,250	7.00	.28	.30	1.60	.18	.35	50
-18	1,500	6.90	.29	.30	1.70	.19	.40	80
-15	1,750	6.80	.29	.29	2.90	.20	.50	200
-12	2,000	6.70	.30	.28	4.00	.22	.75	400
-9	4,000	6.50	.31	.28	5.80	.21	1.20	900
-6	5,000	6.20	.31	.27	5.80	.20	1.70	1,500
-3	6,400	5.60	.31	.26	5.70	.19	1.60	1,700
0	7,700	5.00	.32	.26	5.70	.20	1.40	2,000
+3	6,800	4.50	.33	.25	5.20	.23	1.25	1,800
+6	5,800	4.30	.34	.22	4.00	.24	1.35	1,500
+9	4,800	4.20	.35	.20	3.70	.25	1.25	1,100
+12	4,200	4.50	.36	.20	3.30	.25	.85	800
+15	3,400	4.60	.37	.18	2.70	.26	.80	700
+18	2,500	4.80	.39	.18	2.40	.26	.75	600
+21	2,250	5.00	.40	.16	2.10	.26	.70	500
+24	2,000	5.20	.39	.16	1.80	.25	.65	400
+27	1,900	5.40	.38	.16	1.60	.25	.64	370
+30	1,850	5.60	.37	.14	1.50	.25	.63	350
+36	1,700	5.90	.36	.14	1.30	.25	.60	300
+42	1,500	6.40	.35	.12	1.30	.24	.58	280
+48	1,400	6.80	.35	.10	1.20	.24	.55	250

TABLE 24.--Hourly water discharge and average nutrient and suspended-sediment concentrations during summer storms, Conestoga River at Conestoga, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N		Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
			Before May 1988	After May 1988				
	cfs	mg/l						
-24	300	5.00	0.20	0.08	1.70	0.50	0.72	125
-21	1,000	5.00	.24	.06	2.30	.47	.90	300
-18	2,500	4.90	.26	.06	3.50	.42	1.00	500
-15	3,800	4.80	.28	.08	4.20	.40	1.20	1,200
-12	5,200	4.70	.30	.06	5.00	.38	1.50	1,500
-9	6,300	3.90	.32	.06	5.50	.33	1.55	1,800
-6	7,400	3.20	.32	.06	6.00	.28	1.60	2,000
-3	8,800	2.80	.34	.06	6.00	.29	1.55	2,300
0	9,800	2.50	.34	.10	6.00	.30	1.50	2,000
+3	9,200	2.20	.32	.18	5.70	.33	1.30	1,500
+6	7,600	2.40	.30	.20	3.00	.32	1.10	1,000
+9	6,000	2.60	.27	.20	2.60	.32	.90	700
+12	3,500	2.80	.24	.18	2.30	.32	.70	450
+15	1,800	3.10	.22	.16	2.10	.32	.67	400
+18	1,600	3.50	.22	.16	1.90	.32	.62	350
+21	1,400	3.90	.20	.16	1.70	.32	.58	275
+24	1,200	4.40	.20	.16	1.50	.32	.55	200
+27	1,120	4.50	.20	.16	1.50	.32	.53	160
+30	1,050	4.70	.20	.14	1.40	.32	.52	120
+36	900	5.00	.20	.14	1.40	.32	.50	75
+42	700	5.40	.22	.12	1.30	.32	.45	70
+48	600	5.80	.22	.12	1.30	.32	.40	50

TABLE 25.--Hourly water discharge and average nutrient and suspended-sediment concentrations during fall storms, Conestoga River at Conestoga, Pa., calendar years 1985-89

Hours Before (-) After (+) Peak Water Discharge	Hourly Water Discharge	Nitrite Plus Nitrate as N	Total Ammonia as N		Total Organic Nitrogen as N	Dissolved Phosphorus as P	Total Phosphorus as P	Suspended Sediment
			Before May 1988	After May 1988				
	cfs	mg/l						
-24	500	6.00	0.60	0.16	1.00	0.34	0.40	80
-21	900	5.80	.55	.16	1.20	.34	.44	110
-18	1,400	5.60	.50	.16	1.50	.34	.48	140
-15	1,800	5.40	.45	.16	1.70	.34	.53	220
-12	1,800	5.20	.40	.16	1.90	.34	.56	370
-9	1,800	5.20	.35	.15	1.70	.32	.65	190
-6	2,200	5.20	.30	.14	1.90	.30	.60	210
-3	3,500	5.20	.25	.13	3.00	.29	1.20	600
0	4,400	5.10	.22	.12	4.80	.28	1.80	1,000
+3	3,900	4.60	.26	.16	4.50	.29	1.50	800
+6	3,400	3.80	.30	.18	4.20	.30	1.10	630
+9	2,700	3.70	.33	.14	3.80	.31	.90	560
+12	2,300	3.80	.36	.12	3.40	.32	.70	500
+15	1,900	4.00	.34	.12	3.20	.32	.60	400
+18	1,600	4.20	.34	.13	3.00	.32	.55	320
+21	1,450	4.30	.32	.13	2.80	.32	.53	260
+24	1,300	4.50	.32	.13	2.70	.32	.52	200
+27	1,220	4.60	.32	.13	2.30	.31	.51	160
+30	1,150	4.80	.31	.12	1.80	.31	.50	120
+36	1,000	5.10	.30	.12	1.70	.30	.48	90
+42	920	5.40	.34	.11	1.60	.29	.46	80
+48	850	5.80	.36	.10	1.40	.28	.43	70

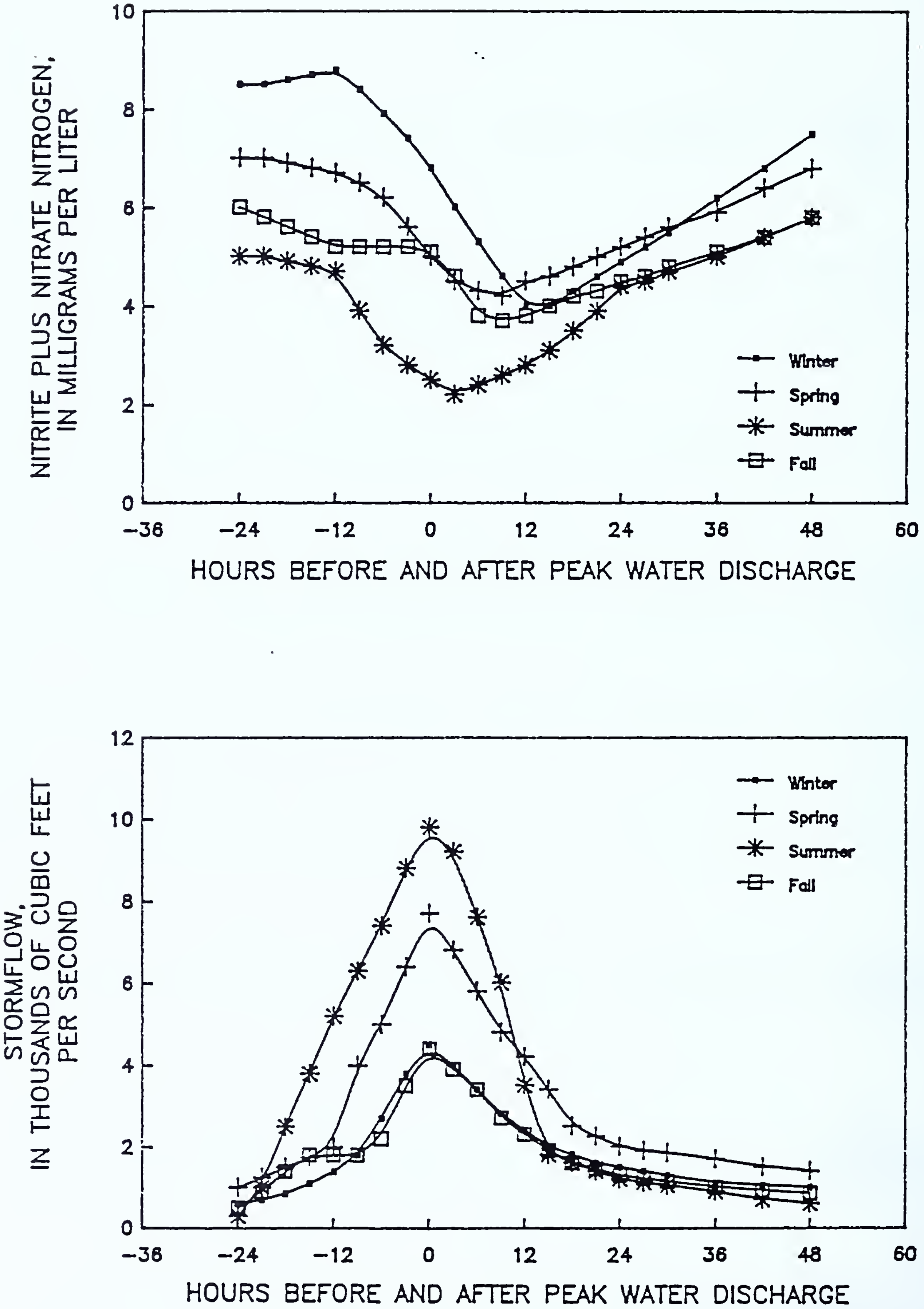


FIGURE 8.--Comparison of seasonal stormflow and average nitrite plus nitrate nitrogen concentrations, Conestoga River at Conestoga, Pa., 1985-89

streamflow was increasing and low concentrations when streamflow was decreasing. Total organic nitrogen and total phosphorus concentrations were highest at/or shortly before the time of peak flow. Dissolved phosphorus concentrations did not change much throughout the storms. Suspended-sediment concentrations also peaked at/or just prior to peak flow.

Stormflow highlights for the three sampling sites are as follows. Stormflow TN concentrations for the Susquehanna River at Danville are lowest in spring and highest in winter, while the TP concentrations are lowest in fall and highest in summer.

Stormflow TN concentrations for Sherman Creek at Shermans Dale are lowest in summer and highest in winter, while the TP concentrations are lowest in winter and highest in spring and summer.

Stormflow TN concentrations for the Conestoga River at Conestoga are lowest in summer and highest in winter, while the TP concentrations are lowest in fall and highest in summer.

NUTRIENT/SUSPENDED-SEDIMENT LOADS AND YIELDS

Loads of nutrients and suspended sediment were computed for each site for the period of data collection, generally for calendar years 1985 through 1989. Loads were computed for total ammonia, dissolved organic nitrogen, total organic nitrogen, total nitrite plus nitrate, total nitrogen, orthophosphate, dissolved phosphorus, total phosphorus, total organic carbon, and suspended sediment. A 7-parameter log-linear model employing seasonality, flow, and time-trend variables was used to estimate constituent loads. This is the same model used to characterize nutrient and suspended-sediment loads at the fall line of the major tributaries entering the Chesapeake Bay. Nutrient and suspended-sediment loads were found to be well described by the log-linear model of the form

$$\ln[C] = \beta_0 + \beta_1 \cdot \ln[Q/\bar{Q}] + \beta_2 \cdot (\ln[Q/\bar{Q}])^2 + \beta_3 \cdot [T-\bar{T}] \tag{1}$$
$$+ \beta_4 \cdot [T-\bar{T}]^2 + \beta_5 \cdot \sin[2\pi \cdot T] + \beta_6 \cdot \cos[2\pi \cdot T] + \epsilon$$

where ln[•] denotes the natural logarithm function, Q is the discharge, and T is time measured in years (Cohn et al., 1989). The errors, denoted ϵ, are assumed to be independent, and normally distributed with zero mean and variance σ^2_ϵ. The β's are parameters of the model which must be estimated from the data. The log-linear model relates constituent concentration to water discharge, seasonal effects, and long-term time trends and computes the best fit regression equations. Daily loads of the constituent are calculated from the mean daily water-discharge records. Mean monthly and annual loads are reported in terms of mean daily loads along with estimates of accuracy. The model has been shown to produce comparable loads to the flow duration--constituent rating curve method described by Miller (1951). The Miller method uses the relation between constituent concentration and water discharge at the time of sample collection, or the relation between daily constituent load and daily mean water discharge, and integrates it with the flow duration curve for the year.

Tables 26 through 35 list the computed annual loads and their corresponding yields of the constituents measured at each of the sites from 1985 through 1989. The loads listed for Codurus Creek at York do not include loads in the water diverted for York's water supply. Loads of nitrogen species, total nitrogen, orthophosphate, dissolved and total phosphorus, and organic carbon have been calculated on an elemental basis.

TABLE 26A.--Annual loads of total nitrogen, calendar years 1985-89

Site Short Name	Total Nitrogen as N									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	30,300	4.2
Danville	43,200	7.4	60,300	4.4	40,100	4.0	31,900	3.9	47,100	4.3
Renovo	79.4	15.5	101	16.8	67.9	12.0	61.5	14.9	90.5	21.9
Lewisburg	29,800	7.3	31,900	4.2	21,200	3.9	17,200	3.8	25,400	4.1
Newport	18,300	4.8	16,700	2.7	13,500	2.4	11,200	2.4	20,100	2.5
Shermans Dale	983	5.7	1,010	4.2	912	3.5	688	3.5	1,660	4.4
Dauphin	27.4	11.7	52.9	10.9	--	--	--	--	--	--
Harrisburg	93,100	6.4	121,000	3.7	87,100	3.3	69,800	3.4	106,000	3.6
Penbrook	33.1	7.0	60.3	5.2	62.7	7.1	55.5	7.8	--	--
Hershey	3,830	4.2	6,320	2.6	5,380	2.6	4,410	2.6	6,520	3.1
Manchester	2,690	6.4	4,080	4.7	3,880	4.7	2,790	4.2	4,970	4.6
York	1,660	4.6	1,690	2.6	1,550	2.4	1,570	2.6	1,760	3.3
Pleasureville	2,530	5.0	2,740	2.7	2,850	2.4	2,740	2.6	2,790	2.9
Marietta	--	--	--	--	114,000	5.4	88,300	4.9	144,000	4.5
Conestoga	7,830	5.3	11,500	2.9	9,830	2.8	10,800	2.8	13,700	3.2
Conowingo	123,000	4.0	156,000	2.7	118,000	2.5	102,000	2.4	157,000	2.8

TABLE 26B.--Annual yields of total nitrogen, calendar years 1985-89

Site Short Name	Total Nitrogen as N				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	6.07
Danville	6.01	8.39	5.59	4.45	6.56
Renovo	2.68	3.42	2.29	2.08	3.06
Lewisburg	6.80	7.28	4.84	3.94	5.79
Newport	8.53	7.80	6.29	5.22	9.37
Shermans Dale	7.68	7.87	7.12	5.38	13.0
Dauphin	1.95	3.77	--	--	--
Harrisburg	6.04	7.86	5.64	4.53	6.88
Penbrook	4.62	8.42	8.75	7.75	--
Hershey	12.4	20.5	17.4	14.3	21.1
Manchester	8.26	12.5	11.9	8.56	15.2
York	11.7	11.9	10.9	11.0	12.4
Pleasureville	14.8	16.1	16.7	16.0	16.3
Marietta	--	--	6.88	5.31	8.68
Conestoga	26.0	38.3	32.7	35.8	45.4
Conowingo	7.10	8.98	6.83	5.86	9.03

TABLE 27A.--Annual loads of total phosphorus, calendar years 1985-89

Site Short Name	Total Phosphorus as P									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	1,890	10.8
Danville	2,160	12.8	4,360	8.0	3,140	7.6	2,270	7.3	3,320	8.5
Renovo	1.76	29.1	2.16	32.7	1.26	21.7	.975	32.5	1.18	46.6
Lewisburg	892	16.9	1,450	9.0	1,260	8.9	1,010	9.0	1,420	9.7
Newport	719	11.3	800	6.4	734	6.1	608	6.3	1,110	6.5
Shermans Dale	40.3	16.6	49.3	13.2	44.1	10.6	30.7	11.5	102	15.5
Dauphin	.891	16.8	3.04	16.8	--	--	--	--	--	--
Harrisburg	3,540	11.7	7,320	7.8	5,540	6.6	4,000	6.7	5,460	7.3
Penbrook	1.19	17.6	5.05	13.8	7.40	25.8	3.26	22.9	--	--
Hershey	104	13.1	229	9.8	206	13.3	144	12.7	252	12.1
Manchester	257	10.6	339	8.4	341	14.7	151	6.7	376	9.8
York	68.3	15.7	60.6	8.4	59.3	8.0	55.9	10.6	53.7	12.3
Pleasureville	134	15.4	152	8.0	171	7.2	166	8.5	161	9.6
Marietta	--	--	--	--	6,650	9.1	5,060	8.7	8,020	8.2
Conestoga	461	14.5	869	9.2	764	12.9	776	9.6	777	9.5
Conowingo	3,600	8.3	5,620	6.5	4,010	5.7	3,200	5.6	5,550	6.5

TABLE 27B.--Annual yields of total phosphorus, calendar years 1985-89

Site Short Name	Total Phosphorus as P				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	0.379
Danville	0.300	0.607	0.438	0.317	.462
Renovo	.059	.073	.042	.033	.039
Lewisburg	.204	.331	.287	.231	.323
Newport	.335	.373	.342	.283	.516
Shermans Dale	.315	.385	.344	.240	.795
Dauphin	.064	.217	--	--	--
Harrisburg	.229	.475	.359	.260	.354
Penbrook	.165	.705	1.03	.455	--
Hershey	.337	.739	.668	.467	.816
Manchester	.789	1.04	1.05	.463	1.15
York	.481	.427	.418	.394	.378
Pleasureville	.784	.891	1.00	.973	.942
Marietta	--	--	.400	.304	.482
Conestoga	1.53	2.89	2.54	2.58	2.58
Conowingo	.207	.324	.231	.185	.320

TABLE 28A.--Annual loads of suspended sediment, calendar years 1985-89

Site Short Name	Suspended Sediment									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	1,530,000	19.8
Danville	1,130,000	16.5	3,660,000	17.0	1,680,000	13.4	942,000	13.1	2,710,000	13.8
Renovo	2,610	61.9	6,240	84.3	1,530	43.3	5,720	133	7,390	96.8
Lewisburg	545,000	25.0	954,000	22.0	444,000	16.5	497,000	24.3	1,040,000	20.1
Newport	336,000	24.8	351,000	18.6	325,000	22.4	288,000	24.6	806,000	19.3
Shermans Dale	21,400	34.7	32,400	36.7	28,000	31.3	16,600	36.3	114,000	48.7
Dauphin	424	45.8	1,430	75.9	--	--	--	--	--	--
Harrisburg	2,040,000	16.4	5,690,000	15.4	2,950,000	12.7	2,050,000	13.8	4,090,000	11.4
Penbrook	3,830	53.7	15,900	56.7	24,000	114	10,300	127	--	--
Hershey	61,400	30.0	241,000	30.1	273,000	51.4	173,000	54.5	337,000	36.9
Manchester	155,000	48.3	260,000	38.1	477,000	94.9	78,500	28.6	431,000	43.7
York	70,600	54.2	34,700	30.3	29,900	31.5	42,600	52.6	47,300	52.2
Pleasureville	58,600	37.6	69,800	21.2	92,100	20.2	109,000	27.0	101,000	25.7
Marietta	--	--	--	--	3,340,000	13.7	3,070,000	14.2	7,360,000	12.2
Conestoga	145,000	41.2	366,000	40.0	399,000	61.3	503,000	34.2	467,000	30.0
Conowingo	958,000	9.8	2,060,000	10.1	1,130,000	8.1	856,000	7.7	1,980,000	8.0

TABLE 28B.--Annual yields of suspended sediment, calendar years 1985-89

Site Short Name	Suspended Sediment				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	307
Danville	158	510	234	131	378
Renovo	88.2	211	51.6	193	250
Lewisburg	124	218	101	114	238
Newport	156	163	151	134	375
Shermans Dale	167	252	219	129	888
Dauphin	30.2	102	--	--	--
Harrisburg	132	368	191	132	265
Penbrook	531	2,210	3,350	1,440	--
Hershey	198	778	881	559	1,090
Manchester	474	797	1460	240	1,320
York	497	244	210	300	333
Pleasureville	343	408	539	636	589
Marietta	--	--	201	184	442
Conestoga	483	1,220	1,330	1,670	1,550
Conowingo	55.2	119	65.2	49.3	114

TABLE 29A.--Annual loads of total ammonia, calendar years 1985-89

Site Short Name	Total Ammonia as N 1985 Load	 1985 Prediction Error	 1986 Load	 1986 Prediction Error	 1987 Load	 1987 Prediction Error	 1988 Load	 1988 Prediction Error	 1989 Load	 1989 Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	1,120	12.0
Danville	2,710	16.1	4,210	10.3	2,360	9.1	1,420	8.8	1,340	9.3
Renovo	1.81	23.4	2.22	23.7	1.78	18.9	1.62	22.8	2.19	37.2
Lewisburg	1,150	18.4	1,360	9.4	954	9.1	645	9.1	723	9.7
Newport	441	17.8	478	11.2	398	10.9	302	10.9	479	11.0
Shermans Dale	17.9	18.0	28.0	15.2	31.0	13.2	19.8	14.2	40.2	18.6
Dauphin	1.76	23.7	2.77	19.8	--	--	--	--	--	--
Harrisburg	1,940	18.1	4,850	11.4	3,950	9.8	2,530	10.0	1,940	10.4
Penbrook	1.16	20.1	2.05	16.1	2.65	32.9	1.54	28.2	--	--
Hershey	133	14.9	259	10.9	165	10.1	110	10.9	132	11.5
Manchester	137	28.5	246	23.3	215	40.1	88.0	17.9	147	26.2
York	64.9	26.8	59.2	13.1	49.1	11.7	42.3	14.6	34.1	18.2
Pleasureville	258	10.8	463	6.7	482	6.0	328	6.5	128	6.9
Marietta	--	--	--	--	4,610	13.4	3,770	12.7	3,800	10.4
Conestoga	351	20.6	744	11.7	586	12.3	415	11.4	193	14.6
Conowingo	5,760	11.7	8,520	8.2	6,760	7.5	5,240	7.3	5,860	8.3

TABLE 29B.--Annual yields of total ammonia, calendar years 1985-89

Site Short Name	Total Ammonia as N				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	0.224
Danville	0.377	0.586	0.329	0.198	.187
Renovo	.061	.075	.060	.055	.074
Lewisburg	.262	.310	.218	.147	.165
Newport	.205	.222	.185	.141	.223
Shermans Dale	.140	.219	.241	.155	.313
Dauphin	.126	.198	--	--	--
Harrisburg	.126	.314	.256	.164	.126
Penbrook	.162	.285	.368	.215	--
Hershey	.427	.838	.531	.353	.427
Manchester	.420	.754	.659	.270	.450
York	.457	.417	.346	.298	.240
Pleasureville	1.51	2.71	2.82	1.92	.749
Marietta	--	--	.277	.227	.228
Conestoga	1.17	2.47	1.95	1.38	.695
Conowingo	.332	.491	.390	.302	.338

TABLE 30A.--Annual loads of total nitrite plus nitrate nitrogen, calendar years 1985-89

Site Short Name	Total Nitrite Plus Nitrate Nitrogen as N									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	16,800	2.6
Danville	21,100	5.7	30,200	3.3	21,700	3.1	18,100	3.1	24,600	3.3
Renovo	36.6	16.4	45.8	17.2	31.9	12.5	29.6	15.0	46.5	22.7
Lewisburg	15,200	4.7	16,900	2.7	12,400	2.6	10,400	2.5	14,400	2.6
Newport	12,900	4.7	11,300	2.6	9,010	2.3	7,680	2.3	14,000	2.4
Shermans Dale	602	6.0	649	4.1	635	3.4	500	3.4	1,040	4.1
Dauphin	3.96	26.3	6.12	34.5	--	--	--	--	--	--
Harrisburg	49,600	6.6	65,400	3.8	50,500	3.5	43,300	3.5	64,000	3.8
Penbrook	14.0	8.6	27.7	6.1	30.2	7.4	31.3	8.7	--	--
Hershey	2,670	5.5	4,530	3.3	4,190	3.2	3,620	3.3	4,970	4.0
Manchester	1,450	8.0	2,510	5.6	2,670	5.1	2,150	5.4	3,300	5.4
York	1,120	5.2	1,230	3.1	1,160	2.9	1,180	3.0	1,350	3.8
Pleasureville	1,650	5.6	1,670	3.1	1,630	2.7	1,590	3.1	1,750	2.7
Marietta	--	--	--	--	68,700	3.6	55,800	3.3	87,400	3.0
Conestoga	6,250	5.5	8,750	3.0	7,680	2.8	8,260	2.8	10,600	3.2
Conowingo	77,800	5.2	99,900	3.5	80,000	3.2	72,000	3.1	113,000	3.5

TABLE 30B.--Annual yields of total nitrite plus nitrate nitrogen, calendar years 1985-89

Site Short Name	Total Nitrite Plus Nitrate Nitrogen as N				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	3.36
Danville	2.94	4.20	3.02	2.52	3.43
Renovo	1.24	1.55	1.08	1.00	1.57
Lewisburg	3.47	3.86	2.84	2.38	3.28
Newport	6.02	5.28	4.20	3.58	6.53
Shermans Dale	4.70	5.07	4.95	3.91	8.15
Dauphin	.282	.437	--	--	--
Harrisburg	3.22	4.24	3.28	2.81	4.15
Penbrook	1.95	3.86	4.21	4.37	--
Hershey	8.63	14.7	13.5	11.7	16.1
Manchester	4.44	7.70	8.17	6.59	10.1
York	7.88	8.64	8.14	8.31	9.47
Pleasureville	9.68	9.75	9.54	9.28	10.2
Marietta	--	--	4.13	3.35	5.25
Conestoga	20.8	29.1	25.5	27.4	35.1
Conowingo	4.48	5.76	4.61	4.15	6.50

TABLE 31A.--Annual loads of dissolved organic nitrogen, calendar years 1985-89

Site Short Name	Dissolved Organic Nitrogen									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	7,030	9.0
Danville	15,100	13.7	17,400	8.0	9,790	7.3	7,100	7.0	11,000	7.8
Renovo	29.8	103	37.0	110	23.8	80	18.6	90	22.1	113
Lewisburg	9,440	13.3	8,540	7.0	5,030	6.7	3,900	6.7	6,320	7.1
Newport	3,830	11.1	3,420	6.0	2,600	5.3	1,900	5.5	2,840	5.8
Shermans Dale	261	10.3	220	7.5	160	6.1	110	6.5	274	8.4
Dauphin	14.6	9.1	28.4	8.0	--	--	--	--	--	--
Harrisburg	31,400	14.0	31,600	7.2	18,800	6.1	13,900	6.3	22,100	6.7
Penbrook	7.27	9.3	16.7	7.2	14.6	10.0	8.23	11.3	--	--
Hershey	569	9.3	919	6.3	675	6.8	430	6.8	584	7.4
Manchester	621	11.4	819	7.1	695	10.3	422	7.1	763	9.4
York	305	9.2	296	5.1	270	4.8	224	5.1	193	6.6
Pleasureville	413	7.0	371	4.0	394	3.6	389	3.8	402	4.1
Marietta	--	--	--	--	23,800	10.9	14,900	10.0	24,600	9.0
Conestoga	575	8.4	963	4.7	805	4.09	897	4.6	1,000	5.0
Conowingo	28,300	10.2	32,000	6.1	21,500	5.0	17,900	4.8	28,700	5.5

TABLE 31B.--Annual yields of dissolved organic nitrogen, calendar years 1985-89

Site Short Name	Dissolved Organic Nitrogen				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	1.41
Danville	2.10	2.43	1.36	0.989	1.53
Renovo	1.01	1.25	.806	.628	.746
Lewisburg	2.15	1.95	1.15	.890	1.44
Newport	1.79	1.59	1.21	.884	1.32
Shermans Dale	2.04	1.72	1.25	.860	2.14
Dauphin	1.04	2.02	--	--	--
Harrisburg	2.04	2.05	1.22	.901	1.44
Penbrook	1.01	2.33	2.03	1.15	--
Hershey	1.84	2.97	2.18	1.39	1.89
Manchester	1.90	2.51	2.13	1.30	2.34
York	2.15	2.08	1.90	1.58	1.36
Pleasureville	2.42	2.17	2.31	2.28	2.35
Marietta	--	--	1.43	.893	1.48
Conestoga	1.91	3.20	2.68	2.98	3.34
Conowingo	1.63	1.84	1.24	1.03	1.65

TABLE 32A.--Annual loads of total organic nitrogen, calendar years 1985-89

Site Short Name	Total Organic Nitrogen as N									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	12,400	4.2
Danville	19,300	14.3	25,900	9.0	16,100	8.2	12,400	7.8	21,200	8.9
Renovo	41.0	32.7	53.2	35.6	34.2	25.4	30.5	34.1	41.8	48.4
Lewisburg	13,400	15.4	13,600	9.2	7,800	8.3	6,180	8.8	10,300	9.3
Newport	4,940	4.8	4,940	2.7	4,090	2.4	3,220	2.4	5,630	2.5
Shermans Dale	363	5.7	330	4.2	246	3.5	168	3.5	574	4.4
Dauphin	21.7	11.7	44.0	10.9	--	--	--	--	--	--
Harrisburg	41,600	6.4	50,900	3.7	32,600	3.3	24,000	3.4	40,100	3.6
Penbrook	18.0	7.0	30.3	5.2	29.9	7.1	21.6	7.8	--	--
Hershey	1,030	4.2	1,540	2.6	1,030	2.6	672	2.6	1,420	3.1
Manchester	1,110	6.4	1,320	4.7	1,000	4.7	554	4.2	1,520	4.6
York	478	4.6	402	2.6	348	2.4	344	2.6	385	3.3
Pleasureville	614	5.0	613	2.7	740	2.4	822	2.6	915	2.7
Marietta	--	--	--	--	41,200	5.4	28,700	4.9	53,200	4.5
Conestoga	1,230	14.1	2,040	8.2	1,560	12.1	2,110	8.6	2,900	9.5
Conowingo	39,700	7.4	47,200	5.4	31,600	4.8	24,300	4.6	38,200	5.4

TABLE 32B.--Annual yields of total organic nitrogen, calendar years 1985-89

Site Short Name	Total Organic Nitrogen as N				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	2.49
Danville	2.69	3.60	2.24	1.72	2.95
Renovo	1.39	1.80	1.16	1.02	1.41
Lewisburg	3.07	3.11	1.78	1.41	2.35
Newport	2.30	2.30	1.90	1.50	2.62
Shermans Dale	2.84	2.65	1.92	1.32	4.48
Dauphin	1.55	3.14	--	--	--
Harrisburg	2.69	3.30	2.11	1.56	2.60
Penbrook	2.51	4.28	4.17	3.01	--
Hershey	3.32	4.97	3.34	2.18	4.60
Manchester	3.40	4.06	3.07	1.70	4.66
York	3.36	2.83	2.45	2.42	2.71
Pleasureville	3.59	3.59	4.33	4.81	5.36
Marietta	--	--	2.47	1.73	3.20
Conestoga	4.09	6.76	5.17	7.01	9.64
Conowingo	2.29	2.72	1.82	1.40	2.20

TABLE 33A.--Annual loads of orthophosphate, calendar years 1985-89

Site Short Name	Orthophosphate as P									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	179	14.6
Danville	365	23.8	335	13.7	184	13.3	132	13.0	179	14.2
Renovo	.819	29.0	.943	33.0	.592	18.2	.526	26.0	.855	43.1
Lewisburg	162	19.0	144	10.9	106	11.4	86.6	11.2	90.4	12.1
Newport	439	26.0	241	15.0	131	13.4	81.1	14.0	121	15.3
Shermans Dale	12.4	25.3	6.70	21.6	4.20	17.3	2.52	19.3	11.4	26.9
Dauphin	.416	15.7	.546	13.5	--	--	--	--	--	--
Harrisburg	810	22.5	635	12.8	338	12.1	203	12.2	273	13.4
Penbrook	.270	15.5	.470	11.3	.513	19.7	.236	15.6	--	--
Hershey	44.2	18.5	30.9	13.0	16.9	16.6	10.8	13.5	23.9	15.8
Manchester	149	13.5	130	10.0	104	14.2	47.6	8.5	111	10.9
York	29.8	15.6	17.2	9.3	12.4	9.7	8.54	9.8	7.79	12.9
Pleasureville	60.7	15.6	35.7	9.0	28.3	8.3	25.9	8.9	37.1	9.5
Marietta	--	--	--	--	494	18.4	303	15.9	383	14.6
Conestoga	218	12.7	313	7.4	277	7.8	280	7.3	340	8.0
Conowingo	1,230	17.0	1,040	10.6	588	9.6	389	9.4	612	10.6

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TABLE 33B.--Annual yields of orthophosphate, calendar years 1985-89

Site Short Name	Orthophosphate as P				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	0.036
Danville	0.051	0.047	0.026	0.018	.025
Renovo	.028	.032	.020	.018	.029
Lewisburg	.037	.033	.024	.020	.021
Newport	.204	.112	.061	.038	.057
Shermans Dale	.097	.052	.033	.020	.089
Dauphin	.029	.039	--	--	--
Harrisburg	.053	.041	.022	.013	.018
Penbrook	.038	.066	.072	.033	--
Hershey	.143	.100	.055	.035	.077
Manchester	.455	.399	.318	.146	.339
York	.210	.121	.088	.060	.055
Pleasureville	.355	.209	.166	.152	.217
Marietta	--	--	.029	.018	.023
Conestoga	.724	1.04	.921	.931	1.13
Conowingo	.071	.060	.034	.022	.035

TABLE 34A.--Annual loads of dissolved phosphorus, calendar years 1985-89

Site Short Name	Dissolved Phosphorus as P									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	853	7.2
Danville	464	12.3	1,060	7.6	955	7.2	841	7.0	1,170	7.8
Renovo	.953	19.4	1.19	23.2	.775	14.3	.674	21.6	.899	32.0
Lewisburg	294	13.9	610	8.3	672	8.5	582	8.2	718	8.8
Newport	332	8.4	389	4.5	370	4.1	314	4.3	474	4.7
Shermans Dale	11.0	11.6	16.9	9.5	20.4	7.9	16.2	7.9	41.2	10.9
Dauphin	.511	16.9	2.08	15.4	--	--	--	--	--	-
Harrisburg	930	12.0	1,930	7.2	1,840	6.7	1,540	6.7	2,180	7.5
Penbrook	.291	9.6	1.03	7.1	1.61	11.5	.921	10.0	--	--
Hershey	38.6	9.7	78.9	6.8	74.3	7.5	59.6	7.4	95.7	8.3
Manchester	154	8.9	186	6.7	175	9.6	89.3	5.7	190	7.6
York	28.9	7.8	26.1	4.6	24.9	4.5	22.1	4.7	23.3	6.2
Pleasureville	65.4	7.4	57.0	4.3	54.6	3.9	48.8	4.2	53.3	4.5
Marietta	--	--	--	--	1,980	7.1	1,780	6.5	2,900	5.8
Conestoga	252	7.7	380	4.4	338	4.8	338	4.3	382	4.8
Conowingo	1,120	15.3	1,810	10.2	1,510	9.1	1,270	8.8	2,150	10.1

TABLE 34B.--Annual yields of dissolved phosphorus, calendar years 1985-89

Site Short Name	Dissolved Phosphorus as P				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	0.171
Danville	0.065	0.147	0.133	0.117	.163
Renovo	.032	.040	.026	.023	.030
Lewisburg	.067	.139	.153	.133	.164
Newport	.155	.181	.172	.146	.221
Shermans Dale	.086	.132	.160	.127	.322
Dauphin	.036	.148	--	--	--
Harrisburg	.060	.125	.120	.100	.141
Penbrook	.040	.144	.224	.128	--
Hershey	.125	.255	.240	.193	.309
Manchester	.472	.582	.535	.274	.583
York	.204	.184	.175	.155	.164
Pleasureville	.382	.333	.320	.286	.312
Marietta	--	--	.119	.107	.174
Conestoga	.839	1.26	1.12	1.12	1.27
Conowingo	.065	.104	.087	.073	.124

TABLE 35A.--Annual loads of total organic carbon, calendar years 1985-89

Site Short Name	Total Organic Carbon									
	1985		1986		1987		1988		1989	
	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error	Load	Prediction Error
	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent	thousands of pounds	percent
Towanda	--	--	--	--	--	--	--	--	79,700	5.3
Danville	105,000	7.9	157,000	4.8	104,000	4.4	79,100	4.2	119,000	4.8
Renovo	--	--	--	--	--	--	--	--	--	--
Lewisburg	49,600	12.8	55,500	7.4	38,800	7.1	31,400	7.1	47,800	7.7
Newport	36,800	13.7	38,800	8.1	33,800	7.5	26,800	7.3	38,600	7.4
Shermans Dale	2,750	15.2	3,040	12.5	2,240	9.8	1,490	10.4	3,490	14.3
Dauphin	159	10.7	287	10.4	--	--	--	--	--	--
Harrisburg	183,000	9.0	278,000	5.0	211,000	8.8	159,000	4.5	199,000	4.8
Penbrook	132	11.4	287	8.5	231	9.5	137	11.3	--	--
Hershey	5,130	11.5	9,230	7.9	6,970	8.2	5,000	8.9	7,250	9.6
Manchester	5,990	9.2	8,690	6.9	7,840	7.6	5,250	5.9	10,500	7.8
York	5,260	7.7	4,870	4.4	4,460	4.4	4.240	4.6	4,340	6.0
Pleasureville	7,880	7.4	7,150	4.0	6,570	3.5	5,910	3.8	5,790	4.1
Marietta	--	--	--	--	231,000	7.4	165,000	6.7	277,000	6.1
Conestoga	11,000	13.2	15,000	7.3	9,850	7.4	9,410	7.1	10,200	7.7
Conowingo	188,000	5.7	288,000	4.1	215,000	3.6	168,000	3.5	246,000	4.1

TABLE 35B.--Annual yields of total organic carbon, calendar years 1985-89

Site Short Name	Total Organic Carbon				
	1985	1986	1987	1988	1989
	pounds per acre per year				
Towanda	--	--	--	--	16.0
Danville	14.6	21.9	14.5	11.0	16.6
Renovo	--	--	--	--	--
Lewisburg	11.3	12.7	8.85	7.18	10.9
Newport	17.1	18.1	15.7	12.5	18.0
Shermans Dale	21.5	23.7	17.5	11.6	27.3
Dauphin	11.3	20.5	--	--	--
Harrisburg	11.9	18.0	13.7	10.3	12.9
Penbrook	18.4	40.0	32.1	19.1	--
Hershey	16.6	29.8	22.5	16.1	23.4
Manchester	18.3	26.6	24.0	16.1	32.0
York	34.0	34.3	31.4	29.8	30.6
Pleasureville	46.1	41.9	38.5	34.6	33.9
Marietta	--	--	13.9	9.90	16.6
Conestoga	36.7	49.9	32.8	31.3	33.7
Conowingo	10.9	16.6	12.4	9.67	14.2

Loads and yields are discussed together because they are mathematically the same values with different connotations. Load values are equated to the quantity of material carried past a given point during a specific time period. Yield values are equated to the quantity of material derived from a unit of area over a specific time period. Yield values, therefore, can readily be compared between subbasins regardless of size variations.

Nutrient and suspended-sediment loads fluctuated with discharge year-by-year at all sampling sites. The total nitrogen, nitrite plus nitrate nitrogen and organic nitrogen loads were generally highest during the year when the discharge was higher and lower during the lowest discharge. The exception was Codorus Creek where the discharge and nitrogen loadings remain nearly the same over the 5-year period at both sampling sites.

Total ammonia loads generally followed the same pattern except at the Conestoga River. The mean discharge in the Conestoga River increased from 102 percent of the long-term mean in 1987 to 111 percent in 1988, but the total ammonia load decreased by 171,000 lbs (29 percent). In 1989, the mean discharge increased from 111 percent of the long-term mean in 1988 to 135 percent in 1989 and the total ammonia load decreased by 222,000 lbs (53 percent). This change in total ammonia loading can probably be attributed to the new regional municipal wastewater treatment plant, which went into operation in May 1988. A significant decrease in the total ammonia load was also noted in 1989 in the Codorus Creek at Pleasureville. The mean discharge at Pleasureville increased from 82.7 percent of the long-term mean discharge to 95.3 percent of the total ammonia load deceased by 200,000 lbs (61 percent). This decrease in ammonia loading can also be attributed to upgrading of the York Municipal Wastewater Treatment Plant, which was completed in 1989. Although the total ammonia loads decreased, total nitrogen loads increased at both sites, since the ammonia was released to the streams in the oxidized nitrate form.

Total and dissolved phosphorus loads were generally highest during the years with the higher discharges. However, the total phosphorus load from the Conestoga River at Conestoga remained the same for 1988 and 1989, even though the discharge increased from 111 percent of long-term mean discharge in 1988 to 135 percent in 1989. The absence of a corresponding increase in total phosphorus load can be partly attributed to the phosphorus reduction in the discharge from the new regional municipal wastewater treatment plant. Orthophosphate loads were the lowest during the years when the discharges were lowest, but did not necessarily correspond with the higher annual discharges. Suspended sediment and total organic carbon loads were also generally highest during the years with the higher discharges.

SEASONAL LOADS OF NUTRIENTS AND SUSPENDED SEDIMENT

Seasonal loads of nutrients and suspended sediment for each of the sites are listed in Tables 36 through 51 Generally, the largest loads were discharged during winter or spring and the smallest loads were discharged during summer. The largest loads are almost always associated with the largest water discharges and the smallest loads with the smaller water discharges.

The mean seasonal loads of nitrite plus nitrate in the Susquehanna River at Danville during the study were 7,950,000, 6,950,000, 1,720,000, and 6,530,000 pounds in winter, spring, summer and fall, respectively. The largest loads were 12,400,000 pounds in the winter of 1986 and 12,500,000 pounds in the spring of 1989. The smallest load was 1,040,000 pounds in the summer of 1988. Loads of total nitrogen followed the

TABLE 36.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Susquehanna River at Towanda, Pa., calendar year 1989

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phosphate as P	Dissolved Phosphorus as P	Total Phosphorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1989	Winter	7,740	263	1,410	2,470	3,630	6,360	33.2	166	288	15,400	141,000
	Spring	22,100	559	4,250	7,070	8,570	16,200	69.4	436	1,130	46,300	1,250,000
	Summer	3,140	40.3	417	595	1,390	2,030	22.9	74.2	144	4,910	25,600
	Fall	7,310	254	957	2,310	3,180	5,740	53.3	177	325	13,100	117,000

TABLE 37.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Susquehanna River at Danville, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phosphate as P	Dissolved Phosphorus as P	Total Phosphorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	15,300	967	6,040	7,140	7,940	16,100	146	134	577	35,200	324,000
	Spring	9,700	391	3,400	4,230	3,830	8,450	81	94	427	22,800	156,000
	Summer	4,010	148	1,110	1,600	1,270	3,010	26	40	234	10,200	101,000
	Fall	16,000	1,210	4,550	6,340	8,100	15,600	112	196	918	36,700	552,000
1986	Winter	27,000	1,930	7,660	10,900	12,400	25,300	131	369	1,520	63,100	2,090,000
	Spring	17,300	734	4,480	6,500	6,380	13,600	87	269	1,130	39,100	652,000
	Summer	6,680	214	1,420	2,270	2,080	4,560	32	102	491	15,200	153,000
	Fall	18,800	1,330	3,890	6,200	9,300	16,800	85	316	1,220	39,800	760,000
1987	Winter	14,900	788	2,900	4,440	6,980	12,200	57	258	741	28,300	340,000
	Spring	17,600	779	3,710	6,150	6,600	13,500	58	338	1,180	38,200	961,000
	Summer	7,550	240	1,320	2,370	2,520	5,140	27	144	588	16,000	207,000
	Fall	11,500	548	1,860	3,120	5,590	9,250	42	215	632	21,200	173,000
1988	Winter	16,400	681	2,740	4,470	7,780	12,900	51	317	760	28,600	299,000
	Spring	14,700	408	2,620	4,680	5,360	10,500	44	314	933	29,200	505,000
	Summer	3,580	64	501	1,020	1,040	2,130	10	61	204	7,120	38,100
	Fall	8,010	266	1,240	2,210	3,890	6,370	27	147	376	14,200	100,000
1989	Winter	9,740	252	1,540	2,660	4,650	7,560	29	176	351	16,100	111,000
	Spring	33,500	758	6,640	13,000	12,500	26,200	93	714	2,200	71,900	2,300,000
	Summer	5,270	68	819	1,690	1,710	3,470	16	92	273	10,300	69,000
	Fall	11,300	265	2,010	3,830	5,780	9,880	41	192	491	20,700	227,000

TABLE 38.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Young Womans Creek near Renovo, Pa., alendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	93.3	0.732	11.0	15.7	15.2	31.6	0.323	0.384	0.673	--	793
	Spring	60.0	.535	7.31	10.4	8.31	19.2	.232	.258	.435	--	477
	Summer	14.7	.115	1.82	2.24	1.32	3.67	.043	.050	.090	--	23.9
	Fall	88.4	.429	9.60	12.7	11.8	24.9	.222	.260	.563	--	1,310
1986	Winter	113.0	0.833	13.4	20.4	18.0	39.2	0.348	0.473	0.820	--	3,260
	Spring	79.6	.684	9.60	14.0	11.0	25.7	.279	.333	.567	--	881
	Summer	26.4	.188	3.07	3.94	2.64	6.77	.076	.084	.159	--	110
	Fall	103.7	.517	10.9	14.8	14.2	29.5	.240	.295	.614	--	1,980
1987	Winter	56.1	0.544	6.78	9.64	8.62	19.8	0.159	0.229	0.354	--	339
	Spring	74.8	.677	8.64	13.6	11.4	25.7	.245	.319	.502	--	912
	Summer	26.8	.196	2.90	3.88	2.93	7.01	.071	.081	.142	--	96.2
	Fall	52.4	.362	5.51	7.10	7.94	15.4	.117	.146	.258	--	180
1988	Winter	73.4	0.697	7.80	11.9	13.6	26.2	0.201	0.279	0.403	--	528
	Spring	77.4	.651	7.63	13.7	11.2	25.6	.251	.299	.435	--	5,110
	Summer	7.70	.069	.792	1.26	.734	2.06	.018	.027	.035	--	15.3
	Fall	24.8	.198	2.33	3.30	3.98	7.48	.054	.069	.100	--	67.0
1989	Winter	57.4	0.567	5.16	9.33	11.3	21.2	0.169	0.213	0.262	--	1,350
	Spring	156.0	1.15	12.3	25.1	25.2	51.4	.527	.530	.712	--	5,770
	Summer	24.0	.195	1.90	3.32	3.16	6.67	.071	.067	.089	--	131
	Fall	37.1	.279	2.74	4.03	6.79	11.1	.088	.088	.114	--	142

TABLE 39.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, West Branch Susquehanna River at Lewisburg, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phosphate as P	Dissolved Phosphorus as P	Total Phosphorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	13,700	388	3,630	5,040	5,660	11,100	51.7	71.5	245	17,400	169,000
	Spring	10,200	319	2,470	3,410	3,540	7,270	36.3	74.5	251	13,600	122,000
	Summer	2,790	90.5	560	740	1,040	1,870	26.1	34.5	90.6	3,830	8,600
	Fall	12,100	348	2,780	4,250	4,970	9,570	48.4	113	305	14,800	245,000
1986	Winter	17,900	483	3,410	5,630	6,490	12,600	47.5	164	445	20,800	475,000
	Spring	11,300	350	1,940	2,940	3,460	6,740	30.3	152	389	13,400	154,000
	Summer	4,170	133	652	917	1,350	2,400	22.9	80.5	172	5,070	22,500
	Fall	14,800	396	2,540	4,130	5,610	10,200	43.6	214	446	16,200	303,000
1987	Winter	9,450	237	1,210	1,810	3,390	5,440	28.4	137	249	9,200	84,200
	Spring	12,800	341	1,780	2,980	3,800	7,120	27.0	220	466	14,000	223,000
	Summer	6,320	174	910	1,380	1,960	3,520	22.1	148	282	7,160	67,400
	Fall	8,560	202	1,130	1,630	3,280	5,110	28.7	167	263	8,430	69,500
1988	Winter	12,700	261	1,530	2,470	4,360	7,090	27.9	202	344	11,900	183,000
	Spring	9,600	216	1,250	2,090	2,800	5,080	20.2	193	373	10,500	220,000
	Summer	3,210	67.5	438	703	1,050	1,820	16.4	80.6	141	3,750	59,900
	Fall	5,430	100	683	915	2,190	3,210	21.8	106	152	5,280	33,700
1989	Winter	10,200	168	1,260	1,890	3,700	5,760	22.9	156	255	9,760	138,000
	Spring	23,200	400	3,640	6,480	6,830	13,700	30.7	382	864	27,400	833,000
	Summer	4,170	73.7	582	827	1,390	2,290	16.0	91.1	158	4,810	27,400
	Fall	5,720	80.6	837	1,110	2,430	3,620	20.8	88.8	139	5,880	43,900

TABLE 40.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Juniata River at Newport, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phosphate as P	Dissolved Phosphorus as P	Total Phosphorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	4,900	102	1,030	1,160	4,180	5,440	128	79.4	165	11,300	56,700
	Spring	4,980	119	1,140	1,540	3,810	5,480	96.3	89.4	221	12,400	92,300
	Summer	878	17.7	228	270	457	745	20.4	23.7	41.2	2,090	4,190
	Fall	4,920	202	1,440	1,970	4,480	6,660	198	139	291	11,000	183,000
1986	Winter	7,260	220	1,450	2,170	5,350	7,740	91.8	146	349	19,100	196,000
	Spring	3,580	90.4	744	1,070	2,270	3,440	40.4	81.9	176	8,780	61,700
	Summer	1,190	30.8	299	394	623	1,050	19.2	38.6	68.6	2,750	12,200
	Fall	3,880	137	930	1,300	3,090	4,520	90.0	123	207	8,210	81,200
1987	Winter	4,090	91.9	679	914	2,730	3,730	41.3	94.7	152	9,030	37,000
	Spring	6,510	210	1,180	2,130	4,000	6,340	40.0	153	397	17,300	249,000
	Summer	1,340	35.7	297	430	701	1,170	16.4	47.3	80.0	2,900	16,000
	Fall	2,330	61.0	442	619	1,580	2,260	33.6	74.3	105	4,520	23,800
1988	Winter	4,730	104	652	1,010	3,040	4,160	30.0	106	181	9,850	59,700
	Spring	4,990	139	779	1,510	2,940	4,590	23.1	120	301	11,600	206,000
	Summer	1,110	23.3	197	308	546	877	9.66	36.6	58.0	2,190	9,070
	Fall	1,770	34.9	267	386	1,130	1,550	18.1	51.1	68.2	3,090	13,200
1989	Winter	4,980	83.4	551	849	3,320	4,250	24.1	97.7	165	9,170	50,500
	Spring	8,050	191	1,070	2,310	5,200	7,700	32.8	171	455	16,200	338,000
	Summer	5,480	166	927	2,030	3,820	6,020	40.6	149	405	10,000	394,000
	Fall	2,270	37.8	295	436	1,680	2,150	23.9	56.2	81.6	3,280	23,500

TABLE 41.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Sherman Creek at Shermans Dale, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	275	3.54	80.0	111	193	307	3.61	2.60	10.4	848	4,860
	Spring	255	4.31	84.6	107	142	254	3.72	2.44	10.5	838	3,510
	Summer	52.0	.987	16.0	18.2	20.0	39.3	.806	.534	2.01	168	408
	Fall	276	9.04	80.6	126	247	383	4.28	5.45	17.3	901	12,600
1986	Winter	471	12.7	110	170	334	517	3.32	7.87	24.7	1,570	17,800
	Spring	263	8.11	67.5	97.6	145	251	2.04	4.17	14.2	900	8,760
	Summer	39.0	.971	8.27	10.2	13.4	24.6	.265	.538	1.41	109	292
	Fall	191	6.29	34.6	51.6	157	215	1.08	4.31	9.02	457	5,490
1987	Winter	253	5.26	34.8	42.9	167	215	.654	4.00	7.37	470	2,500
	Spring	359	12.6	68.9	112	210	335	1.59	7.31	18.6	1,020	11,700
	Summer	95.0	5.08	20.7	35.4	60.4	101	.880	2.73	6.72	265	5,680
	Fall	234	8.08	35.6	56.3	197	261	1.08	6.38	11.4	478	8,200
1988	Winter	306	5.84	33.9	40.4	216	262	0.595	5.60	8.52	463	3,260
	Spring	338	11.2	58.2	103	194	308	1.45	7.70	17.9	809	12,000
	Summer	59.0	1.38	8.60	13.9	27.4	42.7	.256	1.17	2.07	104	640
	Fall	89.0	1.33	9.20	11.3	61.1	73.7	.223	1.73	2.22	110	632
1989	Winter	270	3.19	26.6	31.8	191	226	0.482	4.52	6.31	321	2,090
	Spring	612	16.8	114	248	392	657	4.07	16.6	42.7	1,560	46,800
	Summer	477	18.5	116	267	334	619	6.15	17.0	48.3	1,440	62,800
	Fall	148	1.68	17.4	27.6	126	156	.661	3.07	4.43	165	2,060

TABLE 42.--Seasonal mean water discharge, nutrient, and suspended-sediment loads,
Stony Creek near Dauphin, Pa.,
calendar years 1985-86

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	27.3	0.361	3.65	5.41	1.19	6.95	0.163	0.082	0.138	23.8	65.3
	Spring	34.7	.730	6.29	9.51	1.61	11.8	.171	.220	.480	68.4	220
	Summer	11.1	.290	1.64	2.12	.441	2.85	.029	.070	.120	21.1	43.9
	Fall	26.5	.380	2.97	4.63	.725	5.73	.054	.140	.152	45.4	94.2
1986	Winter	66.3	0.714	10.0	17.0	3.36	21.1	0.252	0.746	1.14	124	804
	Spring	48.4	.891	10.2	16.3	1.88	19.0	.197	.917	1.50	109	445
	Summer	15.0	.589	3.65	4.65	.425	5.66	.036	.219	.264	33.5	111
	Fall	21.4	.574	4.51	6.10	.452	7.13	.061	.197	.138	21.1	67.9

TABLE 43.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Susquehanna River at Harrisburg, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	5,230	475	11,500	13,500	17,900	31,900	276	217	842	54,400	414,000
	Spring	27,000	405	9,290	10,600	10,200	21,200	210	228	830	47,500	379,000
	Summer	7,930	127	2,040	2,750	2,000	4,880	68.6	90.8	280	15,400	53,200
	Fall	35,200	936	8,610	14,700	19,500	35,100	255	394	1,590	65,400	1,190,000
1986	Winter	57,000	2,020	13,500	21,100	27,100	50,200	229	623	2,930	108,000	3,210,000
	Spring	34,400	1,030	8,700	12,300	12,800	26,100	162	491	1,710	69,400	966,000
	Summer	12,500	334	2,590	4,210	3,720	8,240	73.2	223	631	26,300	159,000
	Fall	38,300	1,470	6,780	13,200	21,800	36,500	170	588	2,050	73,700	1,350,000
1987	Winter	30,700	1,080	5,090	7,800	15,300	24,200	84.9	397	1,180	54,100	470,000
	Spring	39,500	1,610	7,590	13,100	15,400	30,100	110	683	2,390	80,600	1,790,000
	Summer	16,200	498	2,740	5,390	6,140	12,000	66.5	358	954	33,300	355,000
	Fall	24,400	755	3,380	6,310	13,700	20,800	77.3	405	1,020	42,600	335,000
1988	Winter	36,800	1,140	5,250	8,440	19,600	29,200	71.7	518	1,400	60,600	649,000
	Spring	32,900	943	5,670	9,990	12,900	23,800	72.9	630	1,780	60,800	1,210,000
	Summer	8,100	158	1,080	2,220	2,450	4,850	22.2	164	342	14,500	62,100
	Fall	15,000	275	1,860	3,330	8,300	11,900	35.7	226	469	22,300	123,000
1989	Winter	25,700	406	3,520	4,900	14,000	19,300	41.1	316	664	34,500	223,000
	Spring	69,700	1,180	12,800	24,500	30,000	55,700	133	1,260	3,610	112,000	3,390,000
	Summer	18,400	187	3,060	5,860	7,340	13,400	50.0	344	686	27,500	269,000
	Fall	20,500	163	2,790	4,780	12,700	17,600	48.2	262	504	24,600	212,000

TABLE 44.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Paxton Creek near Penbrook, Pa., calendar years 1985-88

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	11.5	0.357	1.99	6.19	5.10	11.6	0.055	0.047	0.187	38.1	1,010
	Spring	10.2	.336	2.57	6.02	4.32	10.7	.065	.069	.326	47.2	1,500
	Summer	2.00	.090	.556	1.05	.723	1.87	.030	.028	.108	8.06	273
	Fall	9.80	.379	2.15	4.76	3.82	8.96	.120	.147	.567	38.5	986
1986	Winter	26.7	0.843	6.91	13.6	12.7	27.1	0.144	0.299	1.59	122	6,510
	Spring	13.8	.485	4.70	8.01	6.49	15.0	.090	.211	1.30	79.7	6,250
	Summer	4.20	.180	1.44	2.18	1.59	3.96	.066	.126	.592	21.8	1,220
	Fall	16.2	.537	3.63	6.89	6.90	14.3	.170	.397	1.58	63.2	1,880
1987	Winter	13.8	.249	2.71	4.16	6.07	10.5	0.067	0.217	0.821	50.3	892
	Spring	13.4	.303	3.52	5.52	6.30	12.1	.068	.256	1.25	62.2	2,240
	Summer	17.9	1.55	5.60	13.6	9.66	24.8	.245	.717	3.94	72.2	19,100
	Fall	17.0	.544	2.75	6.60	8.14	15.3	.133	.418	1.39	46.0	1,750
1988	Winter	19.0	0.309	2.39	4.90	9.52	14.7	0.060	0.253	0.798	45.0	804
	Spring	19.0	.664	3.63	10.0	11.9	22.6	.064	.300	1.36	54.4	7,380
	Summer	10.9	.397	1.62	5.57	5.65	11.6	.078	.258	.889	27.1	1,970
	Fall	8.0	.169	.397	2.16	4.16	6.49	.034	.108	.211	10.2	184

TABLE 45.--Seasonal mean water discharge, nutrient, and suspended-sediment loads,
Swatara Creek near Hershey, Pa.,
calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	512	42.4	139	270	748	1,060	14.3	8.77	21.3	1,300	12,400
	Spring	430	23.5	129	235	575	833	8.55	8.11	21.5	1,390	6,660
	Summer	184	7.58	67.7	122	319	449	6.23	4.72	12.0	587	4,190
	Fall	648	59.4	234	398	1,030	1,480	15.1	17.0	49.4	1,850	38,200
1986	Winter	1,260	128	362	638	1,740	2,510	13.1	29.36	88.5	3,740	123,000
	Spring	663	44.7	196	320	879	1,240	5.35	15.7	48.4	2,270	46,900
	Summer	286	11.1	95.9	148	472	631	3.63	8.31	22.3	924	8,430
	Fall	885	75.5	265	430	1,440	1,940	8.85	25.6	69.4	2,300	62,300
1987	Winter	831	58.4	171	230	1,300	1,590	3.91	18.6	41.9	1,870	29,700
	Spring	686	36.5	156	236	959	1,230	2.74	16.4	42.5	1,960	26,000
	Summer	514	31.9	199	347	784	1,160	5.92	20.8	80.2	1,790	184,000
	Fall	644	38.2	148	219	1,140	1,400	4.38	18.5	41.8	1,350	33,300
1988	Winter	921	55.0	149	204	1,440	1,700	3.18	20.9	43.8	1,750	32,000
	Spring	696	31.7	153	278	972	1,280	2.95	19.7	59.5	1,950	115,000
	Summer	320	9.57	72.4	124	538	671	2.27	9.99	24.9	785	15,900
	Fall	326	12.8	54.2	64.9	659	737	2.33	8.78	15.7	506	9,800
1989	Winter	636	25.1	73.5	84.0	1,060	1,170	2.25	13.0	21.9	925	9,550
	Spring	1,490	62.9	277	741	1,860	2,670	8.43	43.2	131	3,690	234,000
	Summer	745	22.4	143	367	1,020	1,410	6.27	22.8	64.1	1,740	57,000
	Fall	600	21.6	91.1	232	1,030	1,280	6.99	16.7	35.7	882	36,400

TABLE 46.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, West Conewago Creek near Manchester, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	534	43.7	177	353	498	985	38.3	36.1	58.3	1,680	40,200
	Spring	431	23.4	152	255	291	570	29.3	31.6	50.2	1,630	18,800
	Summer	160	14.2	71.5	97.1	65.3	177	22.5	23.9	47.3	740	47,700
	Fall	569	55.9	221	404	594	1,050	58.4	62.7	102	1,940	48,000
1986	Winter	1,060	122	380	630	1,280	2,030	54.7	75.2	137	4,000	110,000
	Spring	452	38.2	165	248	374	661	22.2	33.6	62.2	1,930	43,800
	Summer	117	6.41	43.1	61.0	58.0	125	9.67	13.9	24.1	487	9,420
	Fall	624	80.0	231	385	803	1,270	43.7	63.2	116	2,270	97,400
1987	Winter	729	58.7	219	273	1,110	1,440	25.7	42.6	69.6	2,380	35,500
	Spring	507	31.1	159	218	543	792	16.7	30.9	52.9	1,990	22,600
	Summer	203	14.9	75.5	120	153	288	15.9	25.5	47.6	843	28,700
	Fall	676	110	241	391	864	1,370	45.6	75.8	171	2,630	391,000
1988	Winter	812	52.1	213	223	1,390	1,670	22.0	40.6	65.6	2,460	30,100
	Spring	528	29.4	158	245	537	811	17.0	33.7	63.6	2,160	43,700
	Summer	86	2.22	21.4	38.1	46.8	87.1	3.74	6.89	10.9	292	2,530
	Fall	132	3.49	27.3	45.7	158	207	4.55	7.62	10.1	313	1,770
1989	Winter	540	17.3	110	96.1	959	1,070	11.2	20.4	29.4	1,410	9,310
	Spring	1,430	98.8	437	910	1,430	2,440	54.1	102	227	6,290	340,000
	Summer	436	14.6	116	261	354	630	22.3	35.9	64.3	1,600	38,500
	Fall	430	16.6	100	254	557	827	23.0	32.4	55.0	1,160	42,500

TABLE 47.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Codorus Creek near York, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phosphate as P	Dissolved Phosphorus as P	Total Phosphorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	250	31.1	102	198	458	686	7.78	8.00	24.2	1,660	36,200
	Spring	158	8.17	53.3	71.7	276	356	4.74	5.46	8.33	1,210	4,190
	Summer	111	8.50	53.0	79.2	124	211	8.01	6.31	15.6	1,060	19,300
	Fall	188	17.2	96.2	129	262	408	9.25	9.17	20.2	1,320	10,900
1986	Winter	294	26.9	114	158	588	773	5.26	9.28	21.2	1,650	13,000
	Spring	193	13.2	67.4	90.8	351	455	3.68	6.63	14.0	1,270	8,230
	Summer	69	3.67	36.2	45.9	74.9	124	3.47	3.53	6.92	840	1,690
	Fall	148	15.4	78.5	107	213	336	4.76	6.68	18.5	1,110	11,800
1987	Winter	257	21.4	98.6	122	513	656	3.34	7.90	18.5	1,420	8,790
	Spring	180	10.0	59.0	67.9	334	412	2.37	5.85	11.7	1,140	4,240
	Summer	93	5.67	43.0	60.5	106	172	3.21	4.83	12.1	875	6,650
	Fall	145	12.0	69.0	97.7	203	313	3.52	6.28	17.1	1,030	10,200
1988	Winter	252	17.2	83.3	105	509	631	2.24	6.90	16.1	1,300	7,320
	Spring	258	18.0	73.5	137	454	609	2.68	8.46	27.1	1,360	32,400
	Summer	82	3.13	31.3	48.3	95.3	147	1.98	3.57	6.91	782	1,670
	Fall	86	3.78	35.8	53.6	118	175	1.63	3.10	5.73	780	1,190
1989	Winter	165	6.33	43.4	50.2	345	402	1.04	3.69	6.20	966	1,810
	Spring	344	18.7	75.5	184	620	823	2.59	9.76	29.4	1,570	36,900
	Summer	122	3.28	31.1	59.8	155	218	1.97	4.57	7.64	853	2,530
	Fall	159	5.75	43.4	90.1	226	321	2.19	5.30	10.4	950	5,970

TABLE 48.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Codorus Creek near Pleasureville, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	336	57.6	126	179	646	882	18.2	17.0	40.7	2,840	14,100
	Spring	218	61.2	75.8	89.7	393	544	14.7	14.8	25.8	1,700	7,010
	Summer	174	67.1	72.3	139	226	432	14.2	16.2	32.3	1,370	23,100
	Fall	266	72.4	139	207	390	669	13.5	17.4	35.2	1,970	14,500
1986	Winter	383	117	146	209	712	1,040	11.5	17.1	48.5	2,660	22,800
	Spring	257	124	74.9	136	447	707	9.59	15.0	41.0	1,760	19,100
	Summer	121	108	38.4	70.8	165	344	7.04	11.3	24.0	1,030	6,280
	Fall	230	114	120	196	342	652	7.62	13.6	38.7	1,700	21,600
1987	Winter	354	143	137	230	646	1,020	7.73	14.8	50.4	2,320	25,500
	Spring	281	138	86.1	177	472	787	7.77	15.1	48.9	1,690	24,300
	Summer	156	109	56.6	124	199	433	6.51	12.4	34.4	1,080	21,400
	Fall	216	92.0	115	209	313	615	6.35	12.3	7.3	1,480	20,900
1988	Winter	350	109	138	253	629	990	6.59	13.2	48.6	2,090	25,400
	Spring	358	105	117	306	562	974	8.77	17.3	71.7	1,850	67,900
	Summer	135	64.5	58.8	128	177	370	5.84	10.3	26.5	913	10,200
	Fall	136	48.6	36.4	133	213	395	4.71	7.90	19.3	1,050	5,000
1989	Winter	230	45.6	93.3	151	446	642	5.34	8.71	25.6	1,450	7,910
	Spring	455	46.8	136	379	705	1,130	12.4	19.7	78.2	2,040	66,900
	Summer	199	20.9	78.1	184	254	458	9.68	13.0	29.7	1,010	12,300
	Fall	241	14.3	94.6	202	342	558	9.68	11.9	27.6	1,290	13,500

TABLE 49.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Susquehanna River at Marietta, Pa., calendar years 1987-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phosphate as P	Dissolved Phosphorus as P	Total Phosphorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1987	Winter	35,200	1,240	6,310	10,400	21,000	32,700	95.0	482	1,270	64,000	536,000
	Spring	43,200	1,260	9,020	16,900	22,200	40,300	111	672	2,560	91,800	1,900,000
	Summer	17,500	569	4,030	8,610	8,610	15,600	128	337	1,400	33,700	425,000
	Fall	26,900	1,540	4,480	7,430	16,900	25,900	160	489	1,420	41,200	483,000
1988	Winter	39,800	1,800	5,060	9,870	23,600	35,300	97.8	634	1,580	59,400	943,000
	Spring	36,700	1,020	6,010	12,100	18,500	31,600	98.3	671	2,350	66,100	1,800,000
	Summer	8,890	200	1,520	2,720	3,660	6,590	37.1	171	474	15,600	102,000
	Fall	16,200	729	2,240	4,000	9,830	14,600	69.1	303	648	23,300	213,000
1989	Winter	28,600	892	3,260	6,280	17,500	24,600	52.3	468	815	42,000	429,000
	Spring	77,700	1,890	13,600	32,200	42,800	76,900	166	1,550	5,150	156,000	6,000,000
	Summer	21,200	363	3,900	7,610	11,200	19,100	81.7	446	1,220	40,800	522,000
	Fall	22,900	660	3,780	7,150	15,900	23,700	83.0	442	830	38,300	411,000

TABLE 50.--Seasonal mean water discharge, nutrient, and suspended-sediment loads, Conestoga River at Conestoga, Pa., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phos-phate as P	Dissolved Phos-phorus as P	Total Phos-phorus as P	Total Organic Carbon	Suspended Sediment
		cfs	thousands of pounds									
1985	Winter	531	143	141	440	2,140	2,720	51.0	64.4	128	4,250	43,800
	Spring	349	41.9	128	173	1,490	1,700	39.0	44.6	75.1	2,170	12,800
	Summer	325	41.4	140	315	940	1,300	52.4	58.2	117	1,880	62,700
	Fall	510	125	166	302	1,680	2,110	75.5	85.1	141	2,740	25,900
1986	Winter	949	353	283	779	3,320	4,450	86.6	114	286	6,380	101,000
	Spring	551	104	225	336	2,060	2,500	56.8	68.8	153	3,060	41,400
	Summer	507	69.9	239	465	1,360	1,890	78.4	88.2	210	2,460	162,000
	Fall	681	217	216	460	2,010	2,690	91.3	109	220	3,110	61,500
1987	Winter	808	292	208	399	2,890	3,580	75.0	97.2	216	3,790	53,300
	Spring	525	94.3	198	263	1,940	2,300	52.1	63.6	137	2,190	32,100
	Summer	572	99.4	252	662	1,290	2,050	81.3	99.1	283	2,330	288,000
	Fall	494	101	147	236	1,560	1,900	68.5	78.3	128	1,540	25,400
1988	Winter	874	236	243	576	3,000	3,810	74.1	97.3	223	3,400	72,000
	Spring	700	83.9	277	614	2,340	3,050	65.9	81.7	213	2,750	146,000
	Summer	664	51.4	279	747	1,660	2,460	90.2	103	265	2,360	271,000
	Fall	370	41.0	98	173	1,260	1,470	49.5	55.0	74.7	900	14,400
1989	Winter	592	68.5	154	251	2,420	2,740	50.6	61.7	104	1,730	20,700
	Spring	1,380	87.7	502	1,850	4,180	6,120	123	150	414	5,300	355,000
	Summer	655	16.2	203	479	2,050	2,550	92.4	92.9	158	1,810	64,800
	Fall	553	20.9	141	320	1,920	2,260	74.6	77.0	101	1,310	26,200

TABLE 51.--Seasonal mean water discharge, nutrient and suspended-sediment loads, Susquehanna River at Conowingo, Md., calendar years 1985-89

Year	Season	Mean Water Discharge	Total Ammonia as N	Dissolved Organic Nitrogen as N	Total Organic Nitrogen as N	Nitrite Plus Nitrate as N	Total Nitrogen as N	Ortho-phosphate as P	Dissolved Phosphorus as P	Total Phosphorus as P	Total Organic Carbon	Suspended Sediment
		cfs					thousands of pounds					
1985	Winter	40,100	1,830	10,200	13,500	28,900	44,200	443	302	1,040	55,000	282,000
	Spring	31,100	1,370	7,190	10,600	17,600	29,600	272	236	891	46,500	258,000
	Summer	9,640	498	2,210	3,140	4,240	7,880	69.1	84.0	276	15,600	40,900
	Fall	40,400	2,060	8,700	12,500	27,000	41,600	441	499	1,390	71,100	377,000
1986	Winter	66,600	3,380	14,100	19,500	41,800	64,700	393	629	2,320	113,000	1,170,000
	Spring	39,700	1,940	7,310	11,800	21,200	34,900	229	386	1,310	68,200	427,000
	Summer	15,100	794	2,660	4,380	6,930	12,100	91.5	173	487	27,300	83,400
	Fall	44,200	2,400	7,910	11,500	30,000	43,900	324	618	1,510	79,600	377,000
1987	Winter	37,100	2,020	6,230	8,380	25,200	35,600	159	357	953	54,200	235,000
	Spring	44,900	2,250	7,610	12,000	24,800	39,100	174	482	1,580	79,600	625,000
	Summer	18,500	945	2,950	4,960	9,500	15,400	101	268	651	34,900	124,000
	Fall	28,800	1,550	4,670	6,250	20,500	28,300	153	399	830	46,400	146,000
1988	Winter	42,200	2,120	6,810	8,480	30,700	41,300	148	447	1,110	60,400	287,000
	Spring	38,300	1,730	6,110	9,570	22,200	33,500	129	450	1,310	64,400	451,000
	Summer	10,600	514	1,780	2,700	5,310	8,520	34.9	131	312	17,100	44,300
	Fall	17,600	858	3,090	3,540	13,600	18,000	76.3	237	463	25,300	70,400
1989	Winter	30,900	1,330	5,290	5,470	25,000	31,800	94.9	316	724	38,200	163,000
	Spring	82,100	2,850	14,600	21,800	51,500	76,100	285	1,120	3,340	139,000	1,520,000
	Summer	22,600	790	3,940	5,910	14,100	20,800	101	337	772	35,800	166,000
	Fall	25,100	893	4,840	5,010	22,100	28,000	130	378	711	33,600	130,000

same pattern. Mean loads during the winter, spring, summer and fall were 14,800,000, 14,400,000, 3,660,000, and 11,600,000 pounds, respectively.

At most sites, mean concentrations of nitrite plus nitrate and total nitrogen were at their highs in winter, when streamflows are normally high; and lowest during the summer, when flows are normally low. As an example, nitrite plus nitrate concentrations in the Susquehanna River at Danville during 1986 were highest in the winter (0.95 mg/l), when streamflow was at its annual high, and lowest in the summer (0.63 mg/l), when streamflow was lowest. Mean concentrations of nitrite plus nitrate in the Susquehanna River at Danville averaged 0.58 mg/l in the summer of 1988 and 1.07 mg/l during the winter of 1985. The average concentrations, by seasons--winter, spring, summer, and fall--for 1985-89, were 0.98, 0.76, 0.64, and 1.00 mg/l, respectively. Mean concentrations of total nitrogen for the same seasons were 1.82, 1.58, 1.36, and 1.80 mg/l, respectively. The differences between the two, total Kjeldahl nitrogen, were 0.84, 0.82, 0.72, and 0.80 mg/l, respectively.

Similar seasonal variations in concentrations and loads of total nitrite plus nitrate and total nitrogen occurred in Sherman Creek. The highest concentrations and loads were generally in winter and spring and the smallest concentrations and loads were in summer. During the 5-year period, 1985-89, the average concentrations of nitrite plus nitrate, by seasons, were 1.44, 1.21, 1.27, and 1.69 mg/l, respectively; and the seasonal loads averaged 220,000, 217,000 91,000, and 158,000 pounds, respectively. The mean seasonal concentrations of total nitrogen were 1.99, 2.01, 2.30, and 2.33 mg/l, respectively; and the seasonal mean loads transported were 305,000, 361,000, 165,000, and 218,000 pounds, respectively. The mean seasonal concentrations of total Kjeldahl nitrogen were 0.56, 0.80, 1.03, and 0.64 mg/l; and the mean seasonal total Kjeldahl nitrogen loads were 85,000, 144,000, 74,000, and 60,000 pounds, respectively.

The highest seasonal loads of nitrite plus nitrate for each of the 5 years was transported during the fall of 1985, the winter of 1986, the spring of 1987, the winter of 1988, and the spring and summer of 1989. The season with the highest load was the spring of 1989; the load was 392,000 pounds and the mean concentration was 1.30 mg/l. During the 5 years, the four lowest seasonal loads of nitrite plus nitrate were transported in the summers of 1985, 1986, 1987, and 1988. The season with the smallest load, 13,400 pounds, also had the lowest mean concentration, 0.69 mg/l. The load during the summer of 1989 was 322,000 pounds, and the mean concentration was 1.41 mg/l. Loads of total nitrogen followed the same seasonal pattern--highest during the winter and spring and lowest during the summer.

Table 50 lists the seasonal load of nutrients and suspended sediment in the Conestoga River. Nitrite plus nitrate concentrations and loads were generally highest in winter and spring, lowest in summer and then high again in the fall. Average concentrations of nitrite plus nitrate, by seasons, were 7.53, 6.97, 5.39, and 6.52 mg/l; and loads transported during the seasons averaged 2,750,000, 2,400,000, 1,460,000 and 1,690,000 pounds, respectively. The average seasonal concentrations of total nitrogen were 9.49, 9.09, 7.58, and 8.06 mg/l; and the loads were 3,460,000, 3,130,000, 2,050,000, and 2,090,000 pounds, respectively. Concentrations of total Kjeldahl nitrogen were 1.94, 2.12, 2.18, and 1.54 mg/l; and loads were 710,000, 730,000, 590,000, and 400,000 pounds, respectively.

Seasonal loads of total nitrogen followed the same seasonal pattern as total nitrite plus nitrate, which made up about 75 percent of the total nitrogen load.

Loads calculated for the Susquehanna River at Conowingo are listed in table 51. For the period 1985-89, the highest concentrations and loads of total nitrite plus nitrate were measured during winter or spring of each year, and the lowest concentrations and loads were measured during the summers. For the period, mean seasonal concentrations--winter to fall--of total nitrite plus nitrate were 1.44, 1.18, 1.05, and 1.46 mg/l; and the mean seasonal loads were 30,300,000, 27,500,000, 8,010,000, and 22,600,000 pounds. Mean seasonal concentrations and loads of total nitrogen were 2.06, 1.84, 1.70, and 2.06 mg/l; and the mean seasonal loads were 43,580,000, 42,600,000, 12,900,000, and 32,000,000 pounds, respectively. The highest loads of total nitrite plus nitrate generally occurred during winter or spring of each year; however, the highest loads in 1985 were measured during the fall. The smallest loads occurred during the summers. Loads of total nitrogen followed the same seasonal pattern as loads of total nitrite plus nitrate.

The percentages of mean seasonal loads of nitrite plus nitrate measured at Conowingo during the 5 years of data collection that came from the Conestoga River basin were 9.08, 8.73, 18.2, and 7.48, winter through fall, sequentially. The percentages of annual loads measured at Conowingo that came from the Conestoga River were 8.04, 8.76, 9.60, 11.5, and 9.41, for the years 1985 through 1989, respectively. For the 5-year period, 9.39 percent of the nitrite plus nitrate load measured at Conowingo came from the Conestoga River. The Conestoga River basin contains 1.73 percent of the drainage area of the Susquehanna River basin above Conowingo. The percentages of nitrite plus nitrate loads discharged in summer at Conowingo that originated in the Conestoga River basin were 22.2, 19.6, 13.6, 31.2, and 14.6 for years 1985-89, respectively.

During the 5 years of data collection, only in calendar years 1986 and 1989 were the highest nutrient and suspended-sediment loads for a single season coincident with the highest streamflows at all collection sites in the basin. This occurred during the winter of 1986 and the spring of 1989. Streamflow in the basin as gaged at Conowingo, was higher in each of the 2 years, than its long-term average annual. When annual mean streamflows were below the long-term average, as in 1985, 1987, and 1988, the seasons with the highest water discharges did not necessarily coincide with the correspondingly highest nutrient and suspended-sediment loads. Additionally, water discharge in calendar year 1985 ran contrary to the general long-term seasonal trend in discharge (table 52), in that flows during fall exceeded those of winter or spring.

Annual plots of ammonia, in percent of seasonal inorganic nitrogen loads, and corresponding plots of 5-year seasonal means of inorganic nitrogen, in percent of seasonal total nitrogen load, are shown in figure 9. In general, seasonal variations in percent ammonia (upper part of figure 9) are less for the larger streams than for the smaller streams.

There are large point-source discharges from sewage treatment plants above the Danville, Pleasureville, and Conestoga sampling sites. Nutrient concentrations at Danville and Conestoga are similar; presumably because the point discharges are well upstream (10-30 miles) of the sampling sites. Samples from Pleasureville, on the other hand, exhibited less nitrification and, therefore, high ammonia loads--probably because the treated discharge traveled only 3.8 miles to the sampling site. Nutrient loads at all three sites in 1989 were less than those of earlier years. These reduction in loads result from an upgrading of sewage-treatment plants during 1988-89.

TABLE 52.--Long-term seasonal mean water discharges

Site Short Name	Winter	Spring	Summer	Fall
	cfs			
Towanda	15,410	14,980	3,460	8,450
Danville	22,056	21,538	5,244	11,834
Renovo	94.8	109	24.9	62.9
Lewisburg	15,705	15,979	3,642	8,132
Newport	6,707	5,853	1,698	2,897
Shermans Dale	440	389	99	228
Dauphin	--	--	--	--
Harrisburg	50,830	48,210	12,508	25,248
Penbrook	19	18	7	11
Hershey	1,090	975	356	790
Manchester	976	693	251	434
York	324	276	119	156
Pleasureville	--	--	--	--
Marietta	53,520	52,440	13,420	27,860
Conestoga	803	703	365	393

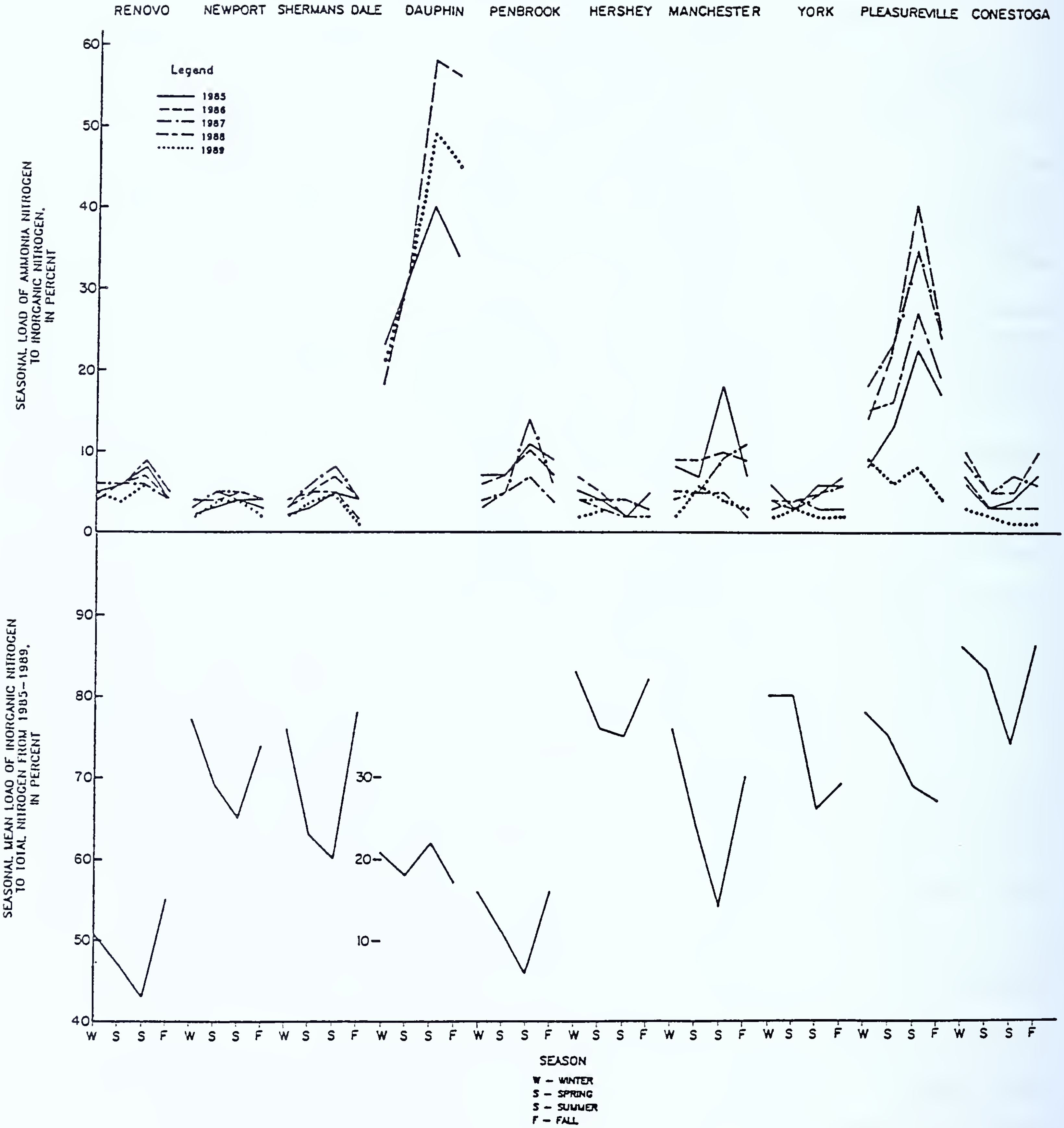

FIGURE 9.--Seasonal variability in ratios of ammonia nitrogen to inorganic nitrogen and inorganic nitrogen to total nitrogen

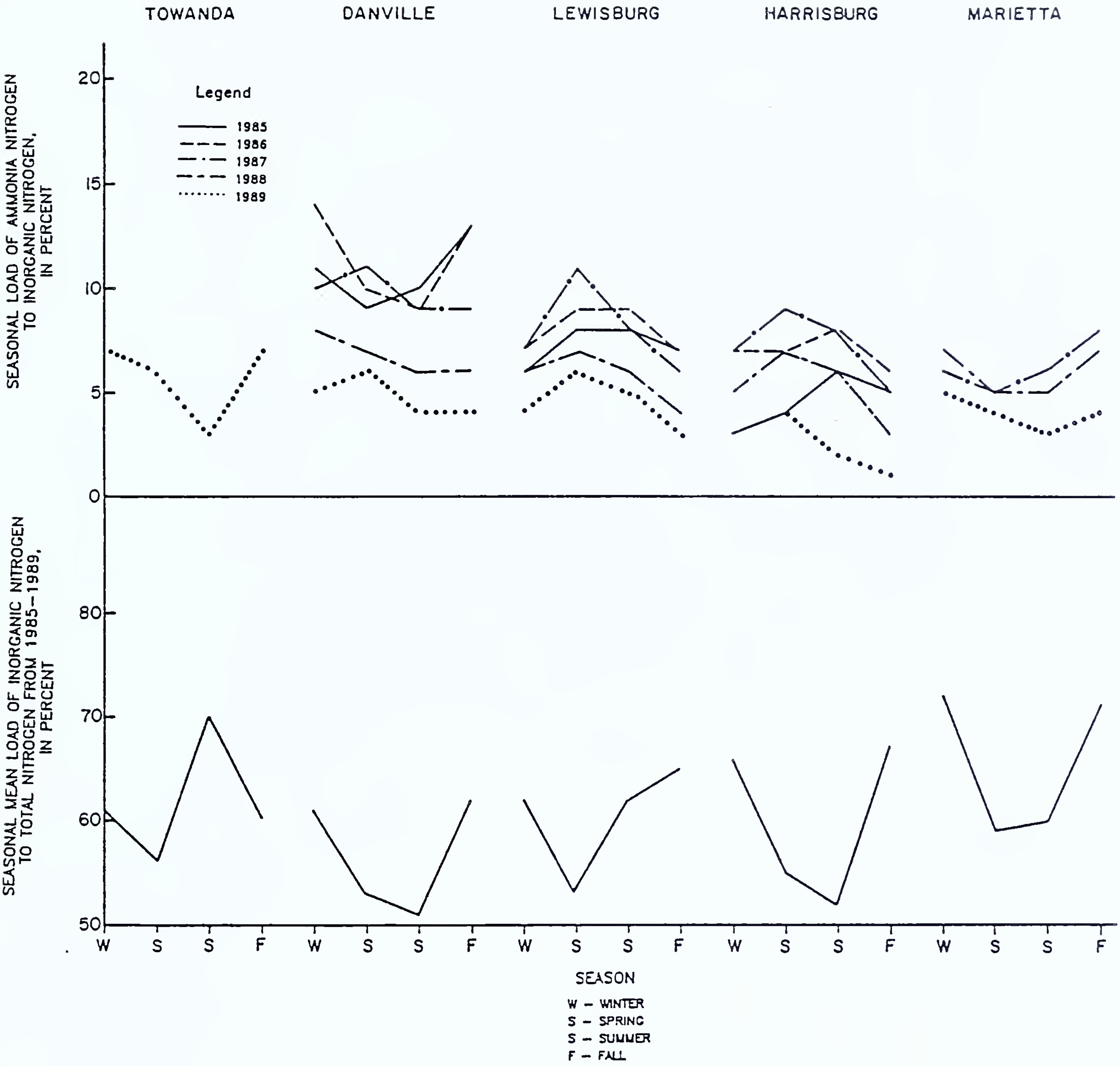

FIGURE 9.--Seasonal variability in ratios of ammonia nitrogen to inorganic nitrogen and inorganic nitrogen to total nitrogen--Continued

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The forested basins above Renovo and Dauphin appear different in that the drainage above Dauphin exhibits a high percentage of ammonia; whereas, flows at Renovo, like those of most non-pristine sites, have less than 10 percent ammonia in the inorganic nitrogen load. It might be expected that forested sites would have a high percentage ammonia because acidic forest soils present a hostile environment for bacterial activity in the nitrification process. Another large difference between the sites is that the nitrogen load at Renovo is half inorganic and half organic; but, at Dauphin it is approximately 80 percent organic.

The percentages of seasonal nitrogen loads that are inorganic, as depicted in the lower half of figure 9, generally decreases from winter to summer for 10 of the 15 sites. This follows the seasonal trend in water temperatures and, probably, reflects the direct relationship between biological activity and temperature. Biological activity converts inorganic nitrogen to organic nitrogen and would, therefore, cause a shift in the relative abundance of species. Of interest is the apparent increase, in a down-basin direction, in the proportion of inorganic nitrogen in nitrogen loads of the sampled tributaries.

With a single exception, the seasonal TN load corresponds directly with the mean seasonal water discharge for the Susquehanna River at Danville, Sherman Creek at Shermans Dale, and Conestoga River at Conestoga -- the season of highest water discharge shows the highest TN load. This is also true of the TP loads, but only for 2 of the 3 sites (Sherman Creek and Susquehanna River at Danville). The Conestoga does show the same relationship, but only from mid-1988 through 1989. This period corresponds to the time when the regional Lancaster City STP dramatically reduced the P concentration in the sewage effluent. This suggests that when the TP input is primarily from a nonpoint source (NPS) a direct relation exists between seasonal loads and water discharge. When point sources (PS) provide part of the overall TP input, a direct relation does not exist between the seasonal load and water discharge.

LOAD SIMILARITIES BETWEEN SAMPLING SITES

The annual yields of total nitrogen, total phosphorus and suspended sediment for each of the sampling sites were used to provide a comparison between sites and to evaluate their relationship with land use. Generally, to TN, TP, and suspended-sediment yields were highest each year in the four tributary streams below Harrisburg. These four tributary watersheds; the Swatara Creek, West Conewago Creek, Codorus Creek, and Conestoga River contain the highest percentage of agricultural lands. The Young Woman's Creek and Stony Creek watershed, which are totally forested, had the lowest yields.

The sampling sites were grouped according to similarities in the ranges of annual yields of TN, TP and suspended sediment over the 5-year period. These groups are shown in table 53, together with the percentages of agricultural and forested lands and manure production in pounds-per-acre for each watershed from table 5.

The Renovo and Dauphin sampling sites are in completely forested basins. They show the lowest TN, TP, and suspended-sediment ranges in yields, and manure production rates. Sites in the next group, which represent the sampled tributaries upstream from Harrisburg, and includes the three main-stem sampling sites, exhibits similar yields of nitrogen, phosphorus and suspended sediment, except for the highest values at Shermans Dale. This site appears to be out of line with the other sites because of the extremely high water of 1989. Penbrook, which has little farming in the basin, has a TN range

TABLE 53. Range in streamflow, nutrient, and suspended-sediment yields, 1985-89

Sampling Site	Range in Nutrient and Suspended-Sediment Yields			Land Use		Manure Production
	Total Nitrogen	Total Phosphorus	Suspended Sediment	Agriculture	Forest	Total Area
	pounds per acre per year			percent		tons per acre
Renovo	2.1 - 3.4	.03 - .07	50 - 250		99.7	0
Dauphin	2.0 - 3.8	.06 - .22	30 - 100		99.7	0
Lewisburg	3.9 - 7.3	.20 - .33	100 - 240	13.9	81.0	.34
Newport	5.2 - 9.4	.28 - .52	130 - 380	25.2	68.8	.81
Shermans Dale 2/	5.4 - 13.0	.24 - .79	130 - 890	24.4	70.2	.76
Penbrook	4.6 - 8.8	.17 - 1.00	530 - 3,400	39.8	18.6	.0014
Danville 1/	4.5 - 8.5	.30 - .60	130 - 510	26.4	49.8	.80
Harrisburg 1/	4.5 - 7.9	.23 - .48	130 - 370	23.0	67.0	.68
Marietta 1/	5.3 - 8.7	.30 - .48	180 - 440	34.9	64.7	.76
Hershey	12 - 21	.34 - .82	200 - 1,100	45.6	37.2	1.77
Manchester	8.3 - 15	.46 - 1.15	240 - 1,460	57.1	35.4	1.44
York	11 - 12	.38 - .48	210 - 500	50.6	39.7	1.30
Pleasureville	14 - 17	.78 - 1.00	340 - 590	44.9	35.2	1.10
Conestoga	26 - 27	1.53 - 2.89	480 - 1,670	62.7	14.6	5.24

1/ Main stem sites

2/ This basin experienced the highest amount of annual precipitation (54.5" in 1989) of all the sampled basins for the 5-year period similar to the other sites in the group. The nearly 40 percent agricultural land is former pasture left idle. The upper limit in the TP range and the overall suspended-sediment range appeared to remove it from the group. However, the high sediment yields resulted from intense development within the small basin. Since phosphorus is intimately bound to suspended sediment, the high sediment yields produced high phosphorus yields. The streams in this group drain areas that produce less than 1 ton of animal manure per acre per year, with about 25 percent of the area in agriculture and 60-70 percent in forest lands. The Lewisburg drainage area, with its 14 percent agricultural and 81 percent forest land, most closely resembles the yields from the forested group.

The third group, which includes three tributary streams downstream from Harrisburg, has higher yields than the two previous groups. The upper limit of the TP range is low at York. The upper limit for suspended sediment at York and Pleasureville is also low, mostly because Indian Rock Dam and three reservoirs dampen high runoff events, thereby lowering the sediment carrying capacity. Notably, the range in annual flows, as a percent of long-term average water discharge was narrow (77-90 percent), yet annual precipitation over the 5-year period ranged from 32 inches to nearly 42 inches. The manure production in the drainage areas for this group was between 1 and 2 tons per acre per year. These areas consist of 45-55 percent agricultural land and 35-40 percent forests. These basins are undergoing significant development.

The Conestoga drainage area with about 63 percent agricultural land, 15 percent forest land and manure production rate of 5.24 tons per acre per year has the highest nutrient and suspended-sediment yield.

A difference between the first two groups and last two groups is disclosed by comparing sediment yields measured during the 1962-67 period (Williams and Reed, 1972) with those of the 1985-89 period. Yield data for these two periods are presented in table 54.

TABLE 54.--Comparison between suspended-sediment yields for 1962-67 and 1985-89

	Suspended-Sediment Yield	
	Long-term Average 1962-67	Range 1985-89
	pounds per acre per year	
Danville	450	130 - 510
Lewisburg	240	100 - 240
Newport	250	130 - 380
Shermans Dale	265	130 - 890
Harrisburg	345	130 - 370
Hershey	690	200 - 1,100
Manchester	690	240 - 1,460
York	695	210 - 500
Conestoga	560	480 - 1,670

Long-term annual sediment yields for the five sites in the first group fall within the 1985-89 ranges, which suggest no trend in yields is occurring. This lack of trend for the 25-year period is not surprising, as there has been little development within the basin upstream from Harrisburg. However, there is some evidence that nitrate-concentrations increased during this period. Such an increase can be noted when comparing present nitrate nitrogen concentrations with the average for 1945-51 at Danville (0.81 vs 0.52 mg/l), Lewisburg (0.67 vs 0.31 mg/l), and Newport (1.33 vs 0.69 mg/l) (Pa. Department of Commerce, 1947 and 1953). The increases are believed due, at least in part, to sewering of much of the urban areas and to less reliance on septic systems. This has brought more sewage, albeit treated, directly to the stream than was possible with faulty septic systems.

Sites in the second group of table 54 show sizable increases in sediment yields over the 25-year period. The 1962-67 sediment yields primarily reflect farming practices and the beginning of the development boom. Farm land acreage has decreased since the early 1960′s (U.S. Bureau of Census, 1989), giving way to housing and industrial development.

DETERMINATION OF AVERAGE BASELINE YIELDS FOR TOTAL NITROGEN, TOTAL PHOSPHORUS, AND SUSPENDED SEDIMENT

The nutrient and suspended-sediment loads and yields have been presented to show their year-to-year variabilities and their relative magnitudes for the sample sites. Other studies have shown the functional relation between load (or yield) and water discharge. The Chesapeake Bay Program nutrient reduction strategy states that reductions will be calculated from point source loads for 1985 and nonpoint source loads in a year of average rainfall. What is average rainfall for a 27,100 square mile drainage basin? It is believed that it is more appropriate to relate nutrient and suspended-sediment loads and yields to a common denominator in order to attempt legitimate comparisons for different sampling periods at the same site, as well as for making comparisons between sites. The functional relation between the loads or yields and water discharge suggests that comparability can be accomplished by relating the yearly loads or yields and the associated annual mean discharges to the long-term average water discharge. This can be accomplished by plotting water discharge, as a ratio of the yearly means to the long-term average, against the annual load or yield. A least squares fitting procedure can be used to produce a line of regression, as shown with the general relation of figure 10.

$$Y = A + B(R)$$

where: Y = annual yield,
A = Y intercept,
B = slope of regression line, and
R = water-discharge ratio.

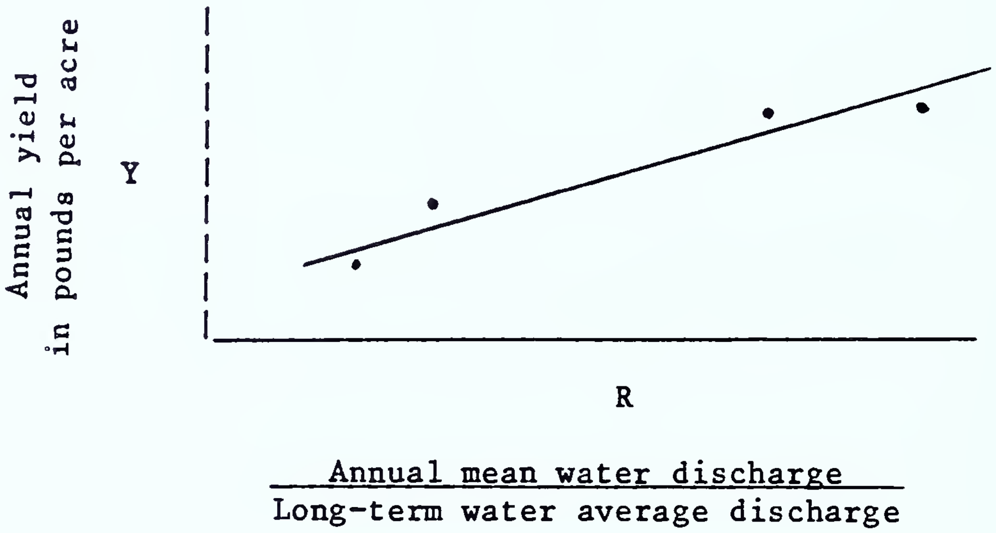


FIGURE 10.--Relation between annual nutrient yield and the annual mean water discharge divided by the long-term average water discharge (water discharge rates)

This procedure is feasible as long as the sampling sites are located at existing long-term gaging stations for which an average flow can be calculated for the period of record.

It was initially hypothesized that, although there might be changes in land use over the 5-year period, the large drainage areas above most of the sampling sites would easily absorb the potential changes in water quality. Therefore, changes in yearly nutrient and suspended-sediment loads would be due primarily to differences in the distribution and total quantity of yearly water discharge. If this hypothesis held, then a correlative relation between the annual-yield values was expected.

The resulting plot or regression line should be thought of as the 1985-89 "baseline". This baseline can be used to estimate an average load or yield for the base-sampling period that has been adjusted to the period of long-term water discharge. This estimate is obtained from the relation as the yield value for a water-discharge ratio (R) of 1 and is termed the "baseline yield".

Figures 11 to 25 show the relation between the annual yields of TN, TP, suspended sediment, and corresponding water-discharge ratios for the sampled sites. The observed error range is ± one standard deviation and is obtained by averaging the prediction errors, in percent, for the 5-year period and applying it to the regression line. The annual baseline yields of TN, TP, and suspended sediment, as determined from the regression equations, are listed in tables 55, 56 and 57.

Nutrient baselines for the sampled sites can be superimposed on one graph for comparative purposes. Figures 26, 27 and 28 show TN, TP, and sediment yields for the sampling sites. These baselines have been divided into four broad groups by using land use, manure production, and average yields for the represented basins, which are summarized in table 58.

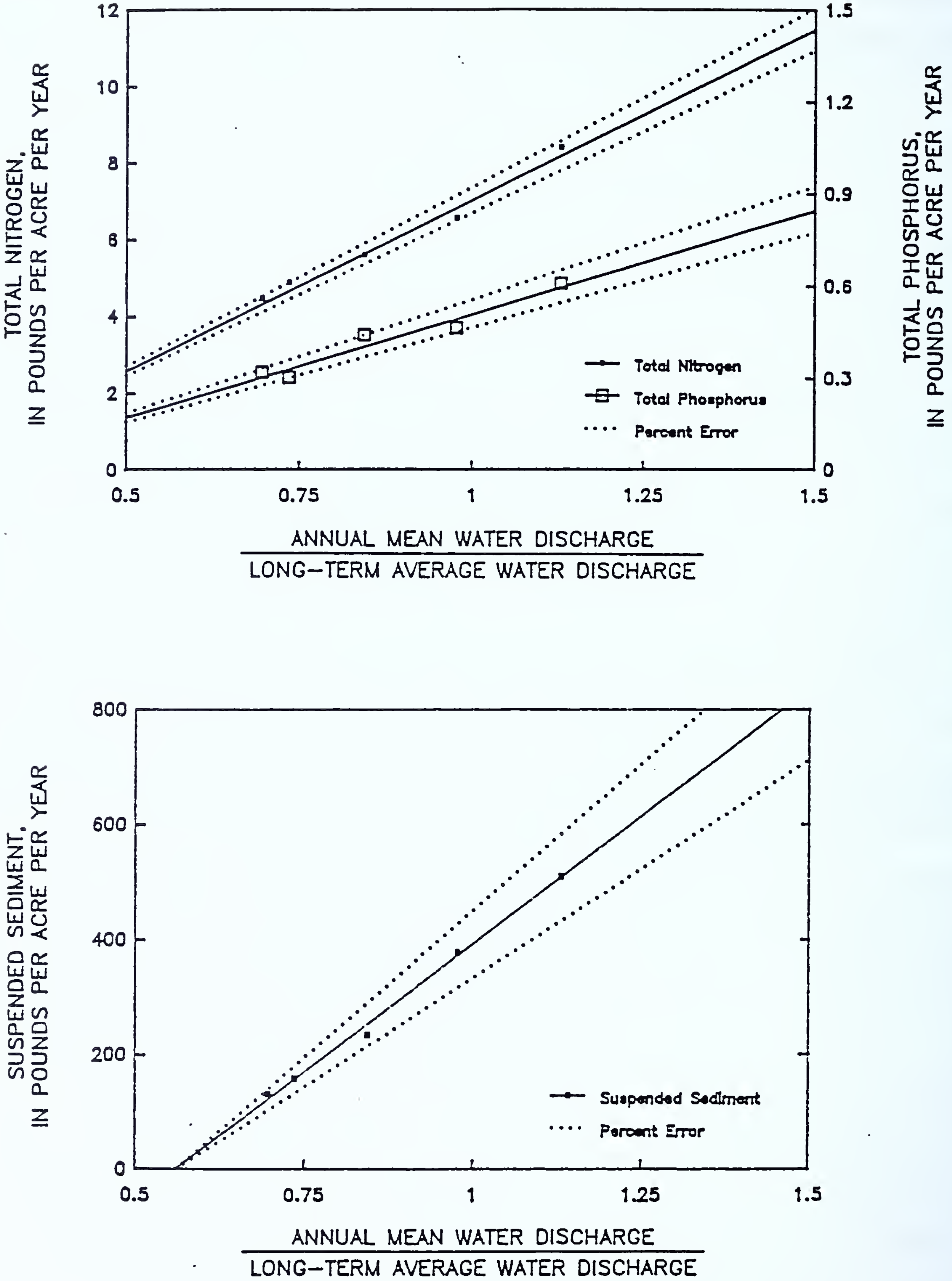


FIGURE 11.--Nutrient and suspended-sediment yields, Susquehanna River at Danville, Pa., 1985-89

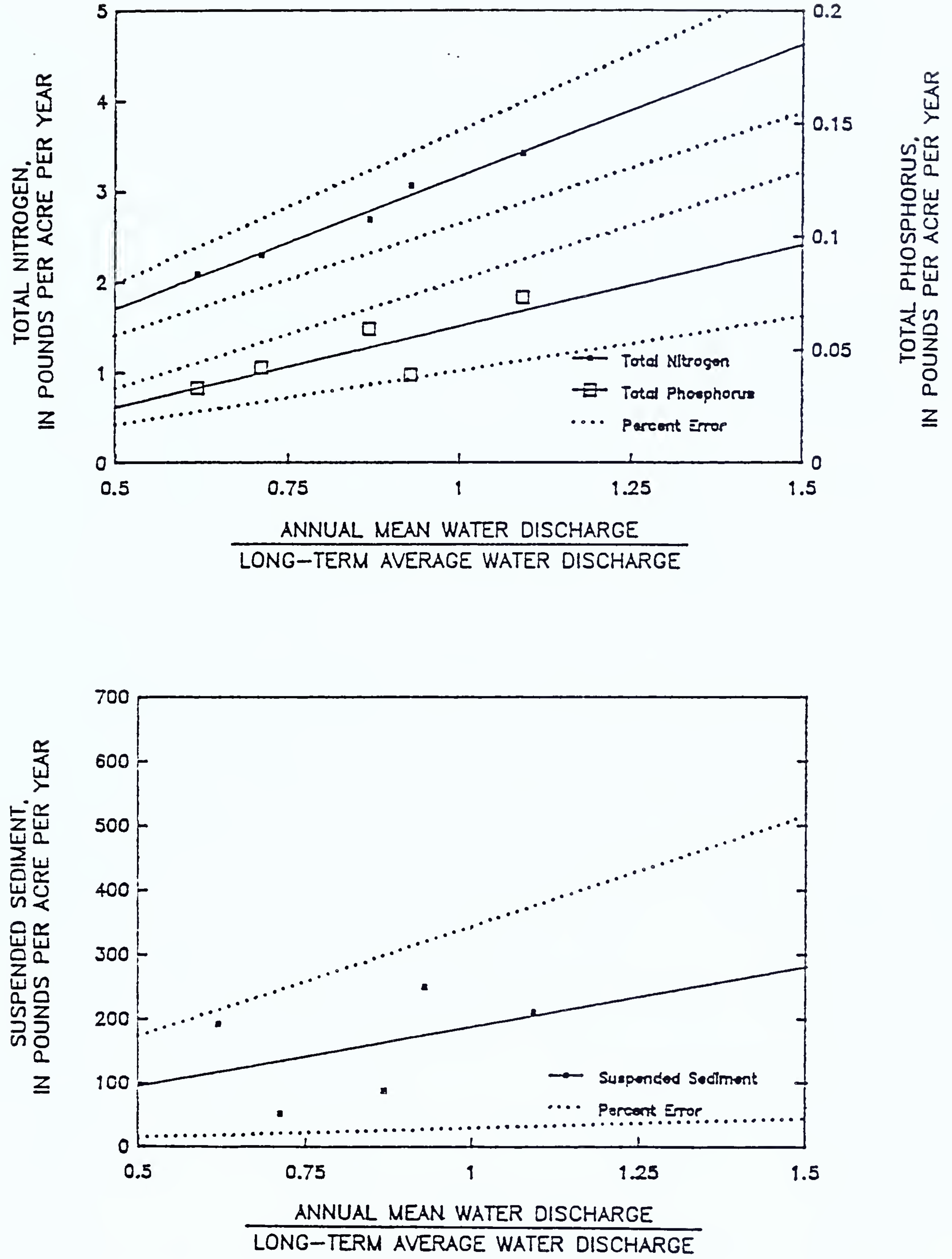
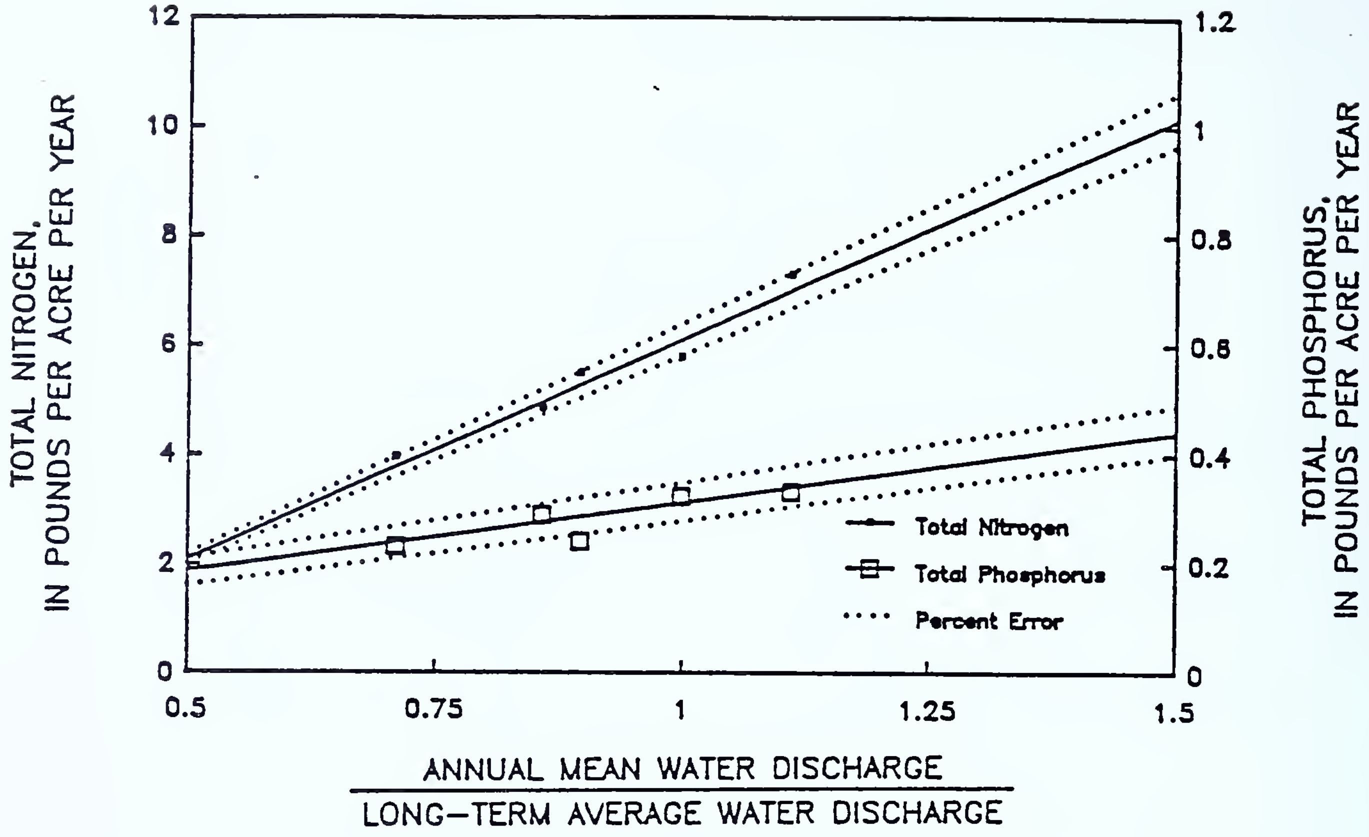


FIGURE 12.--Nutrient and suspended-sediment yields, Young Womans Creek near Renovo, Pa., 1985-89



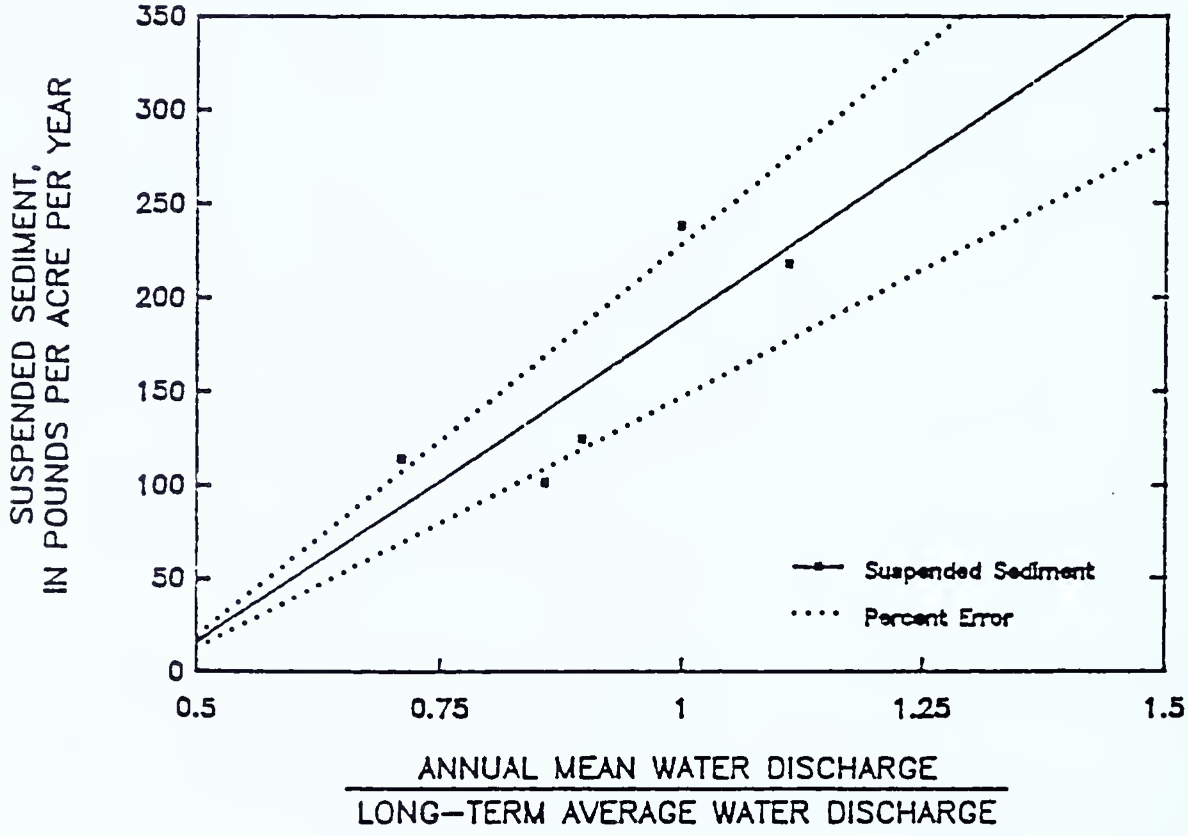
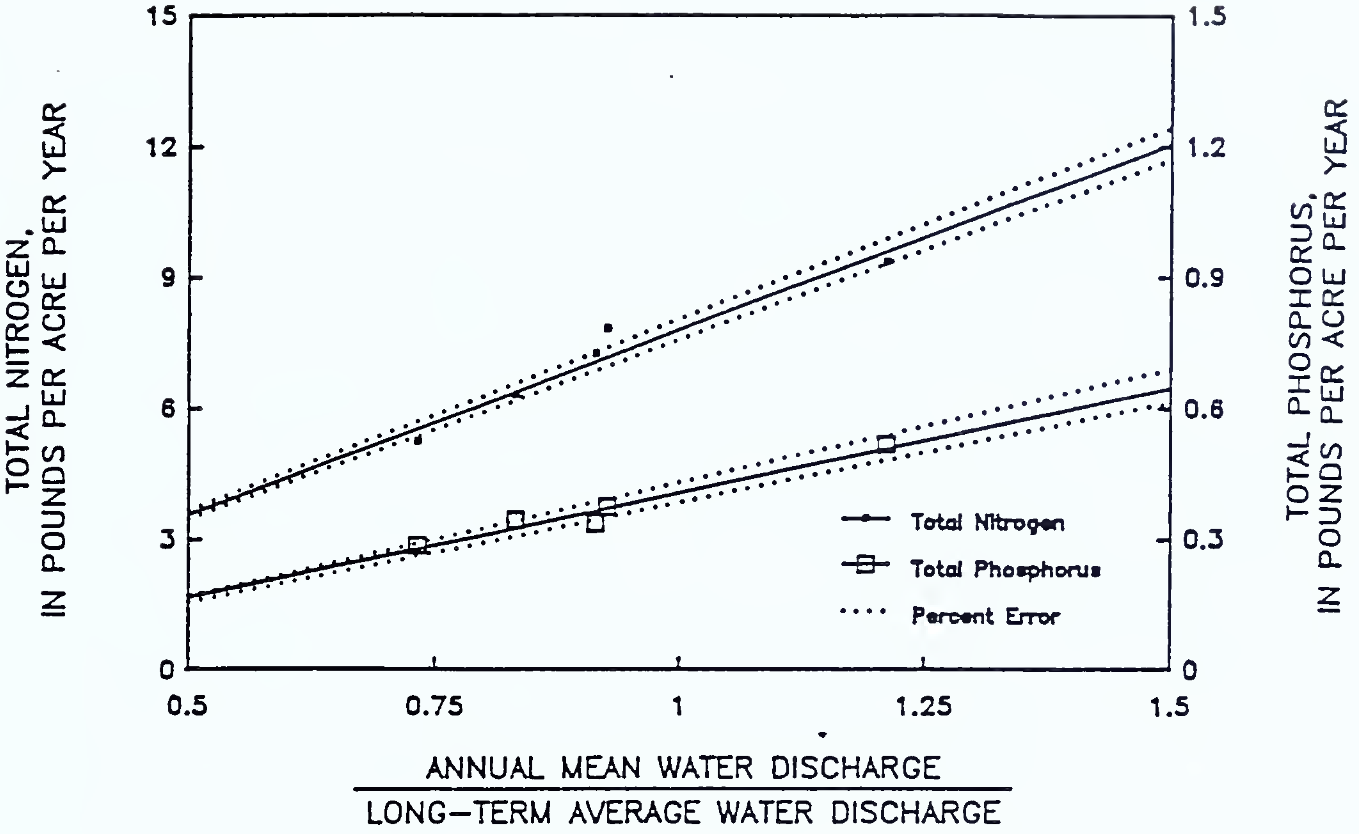


FIGURE 13.--Nutrient and suspended-sediment yields, West Branch Susquehanna Riverat Lewisburg, Pa., 1985-89



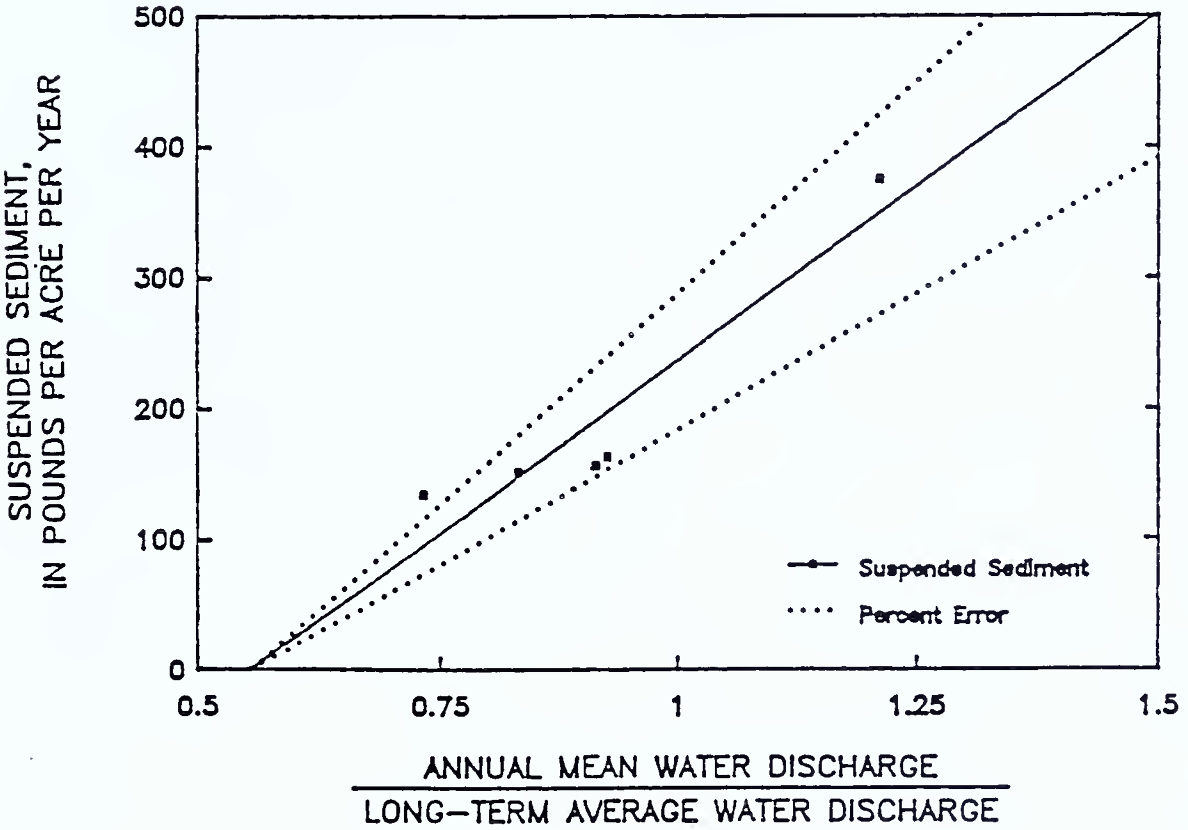
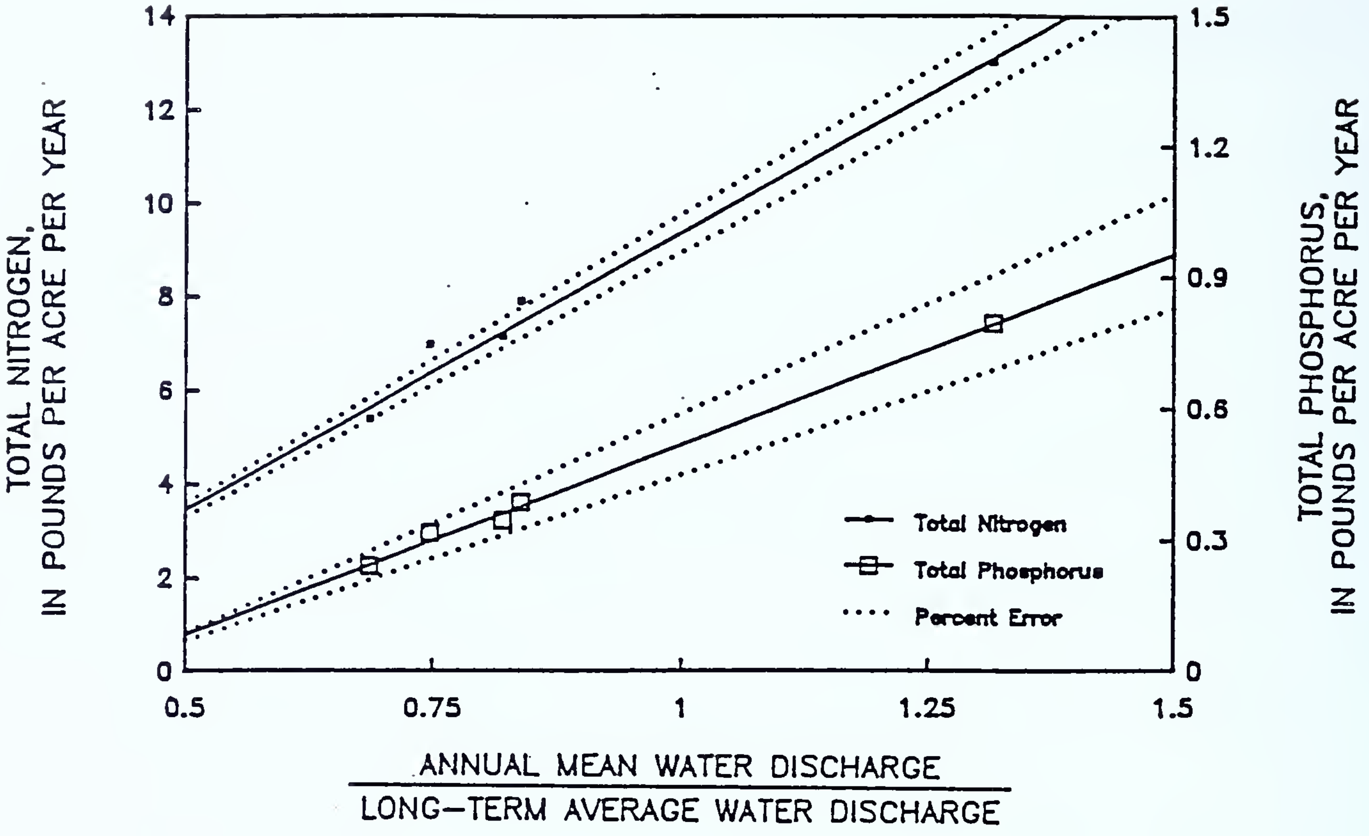


FIGURE 14.--Nutrient and suspended-sediment yields, Juniata River at Newport, Pa., 1985-89



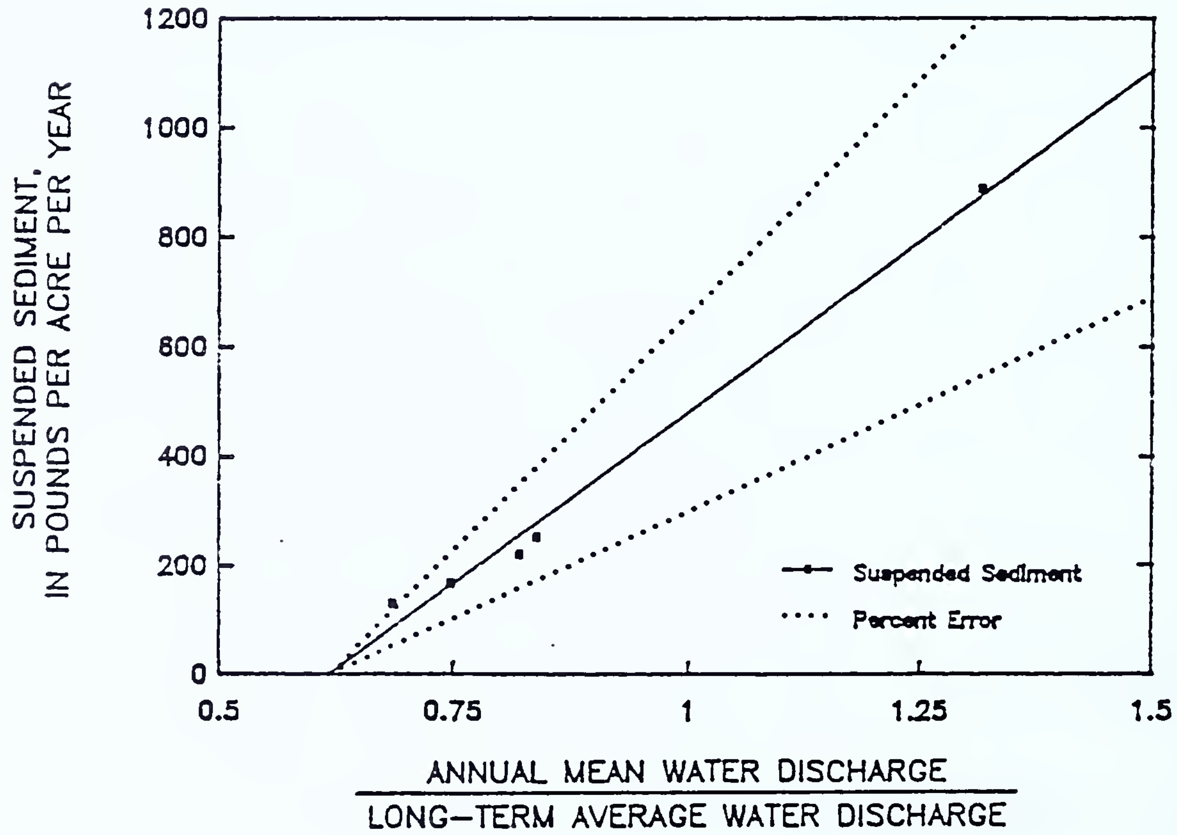
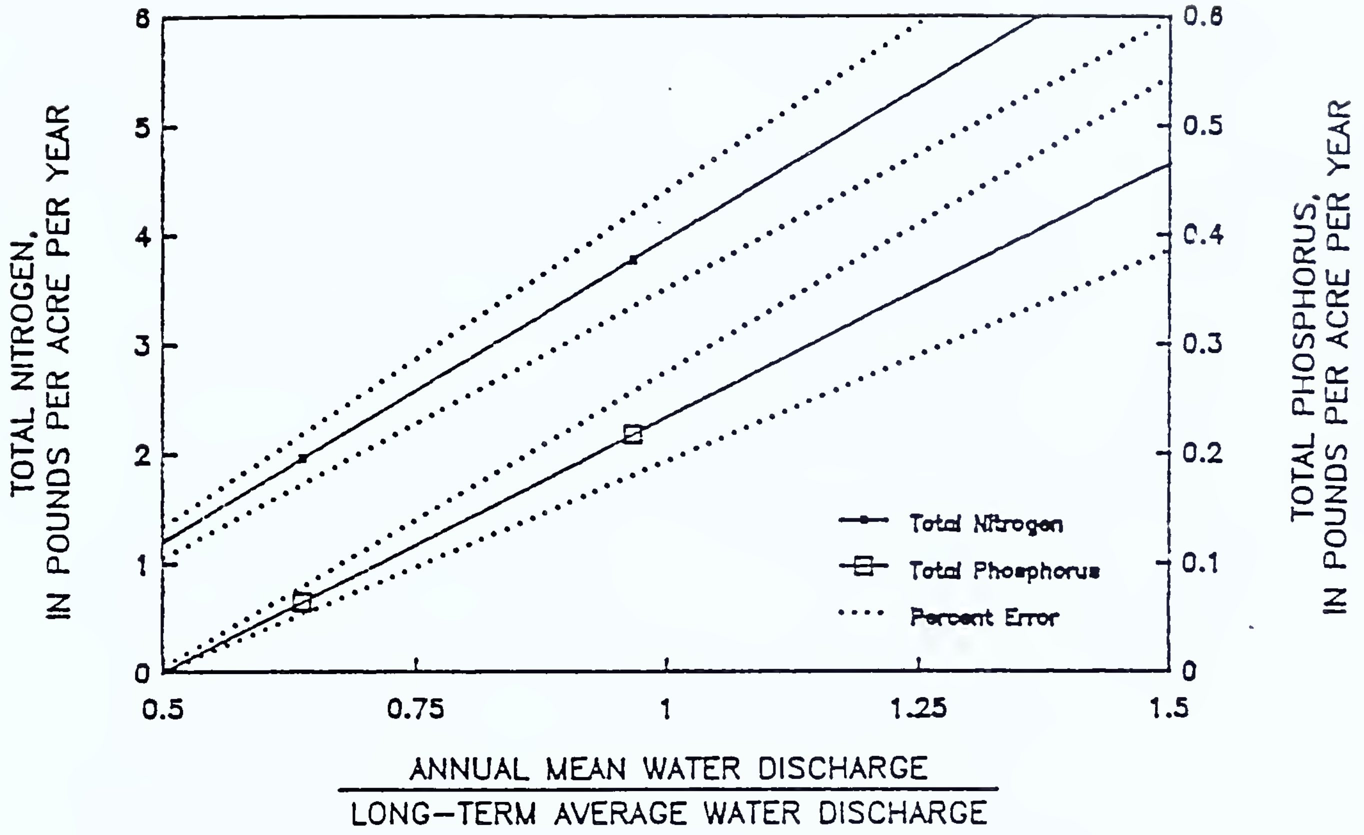


FIGURE 15.--Nutrient and suspended-sediment yields, Sherman Creek at Shermans Dale, Pa., 1985-89



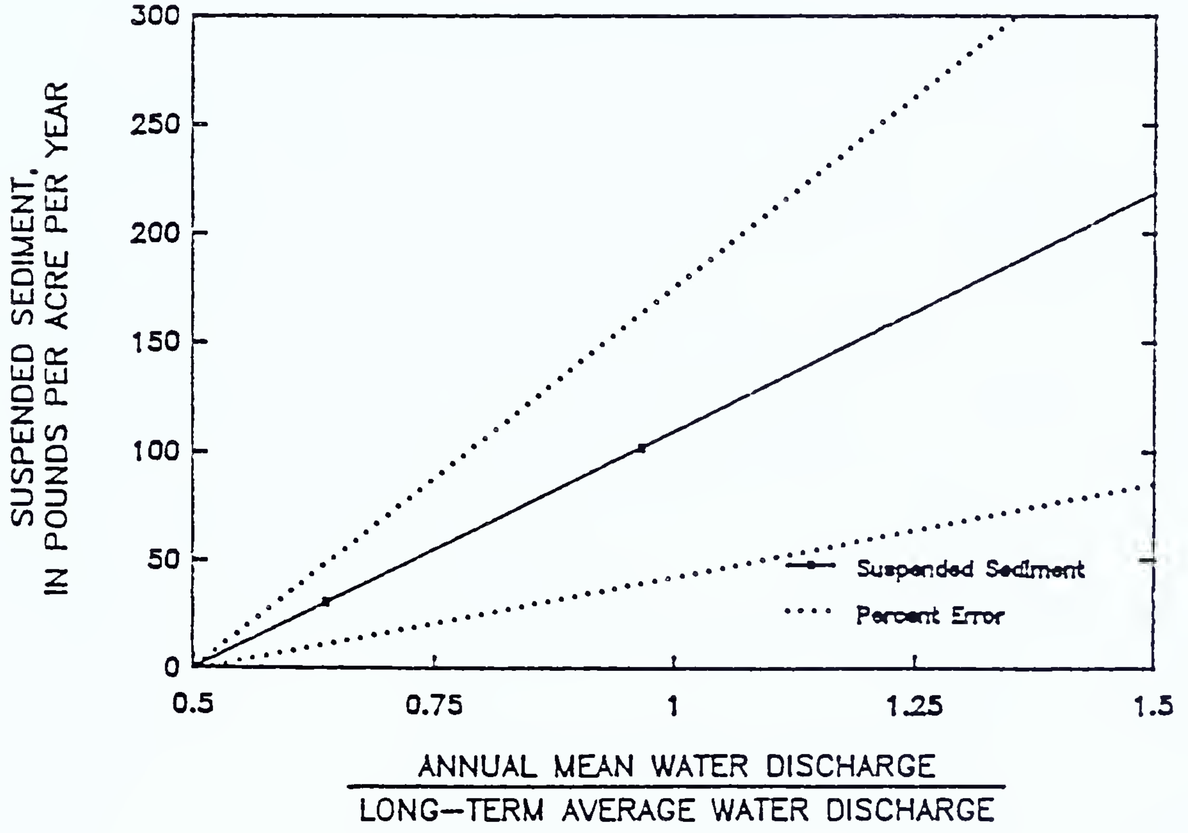
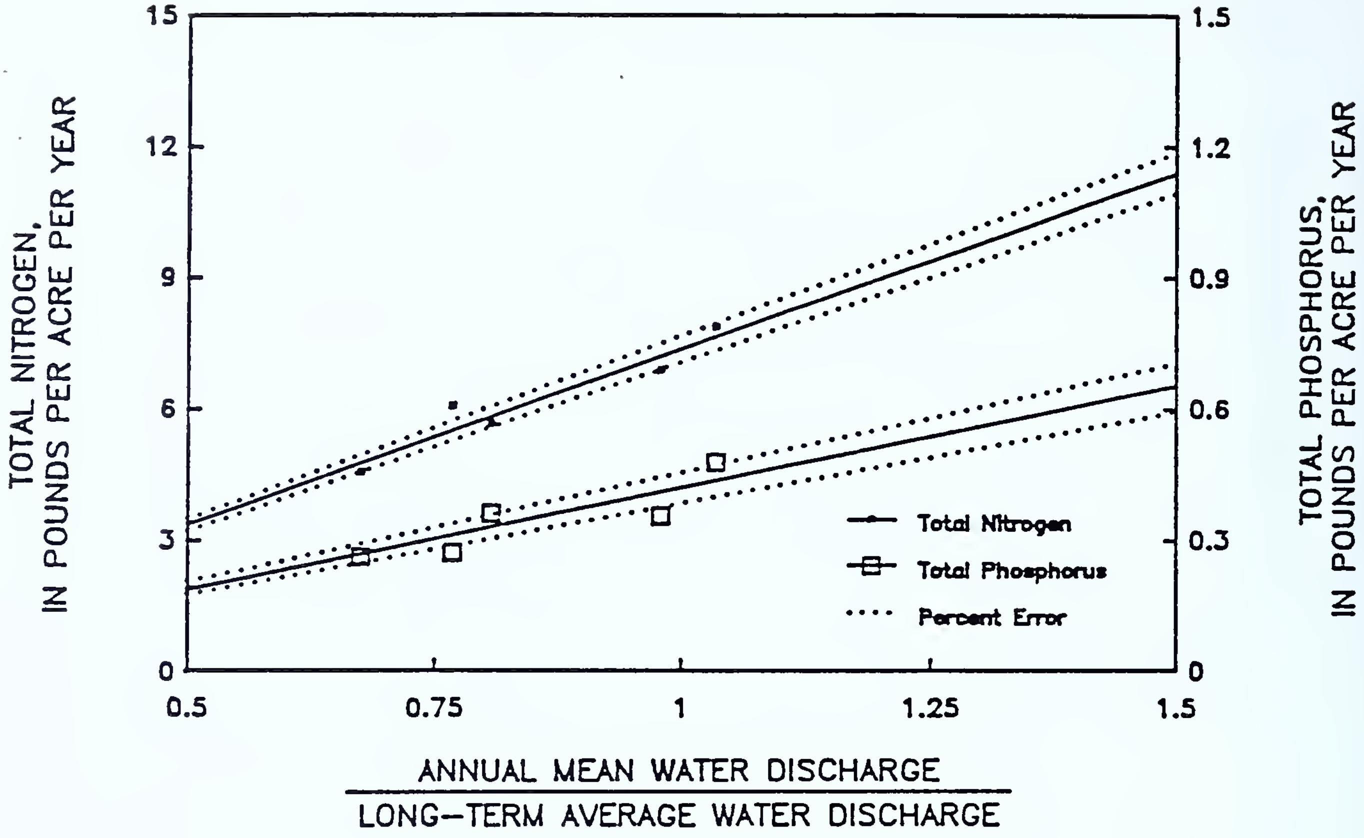


FIGURE 16.--Nutrient and suspended-sediment yields, Stony Creek near Dauphin, Pa., 1985-86



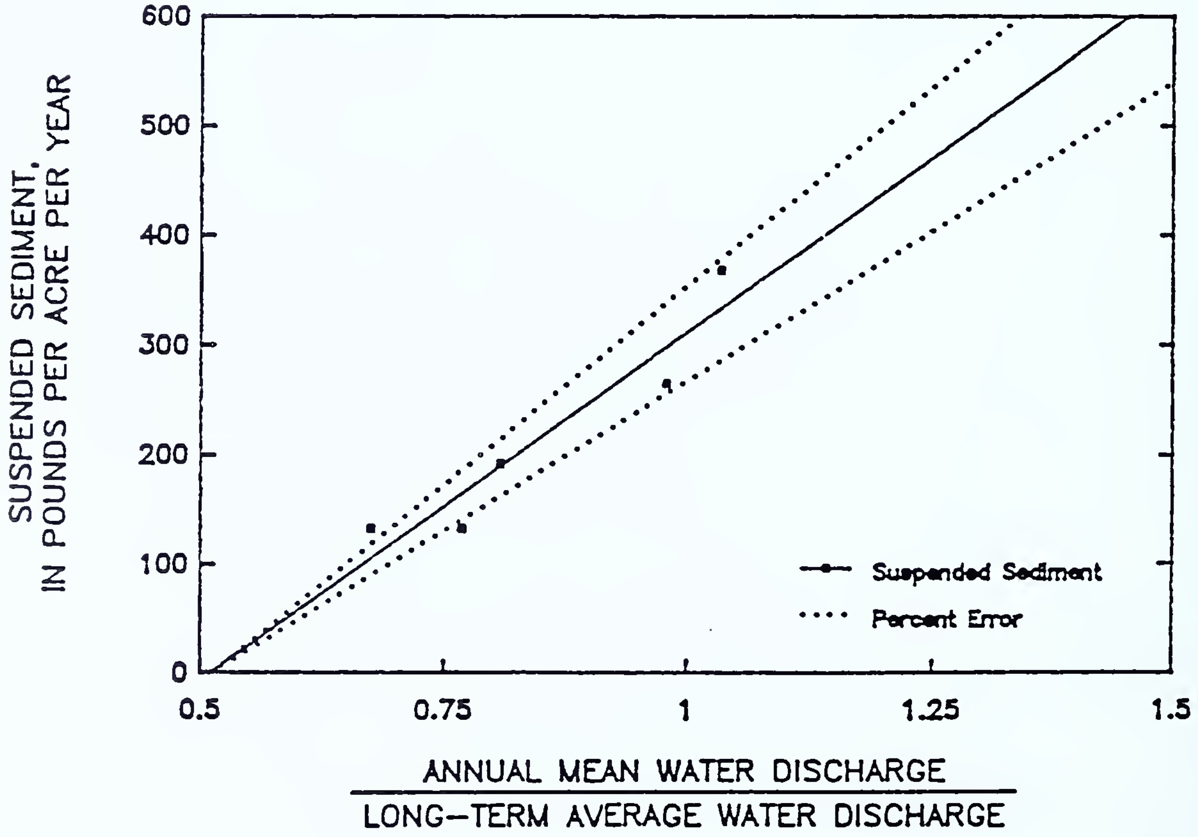


FIGURE 17.--Nutrient and suspended-sediment yields, Susquehanna River at Harrisburg, Pa., 1985-89

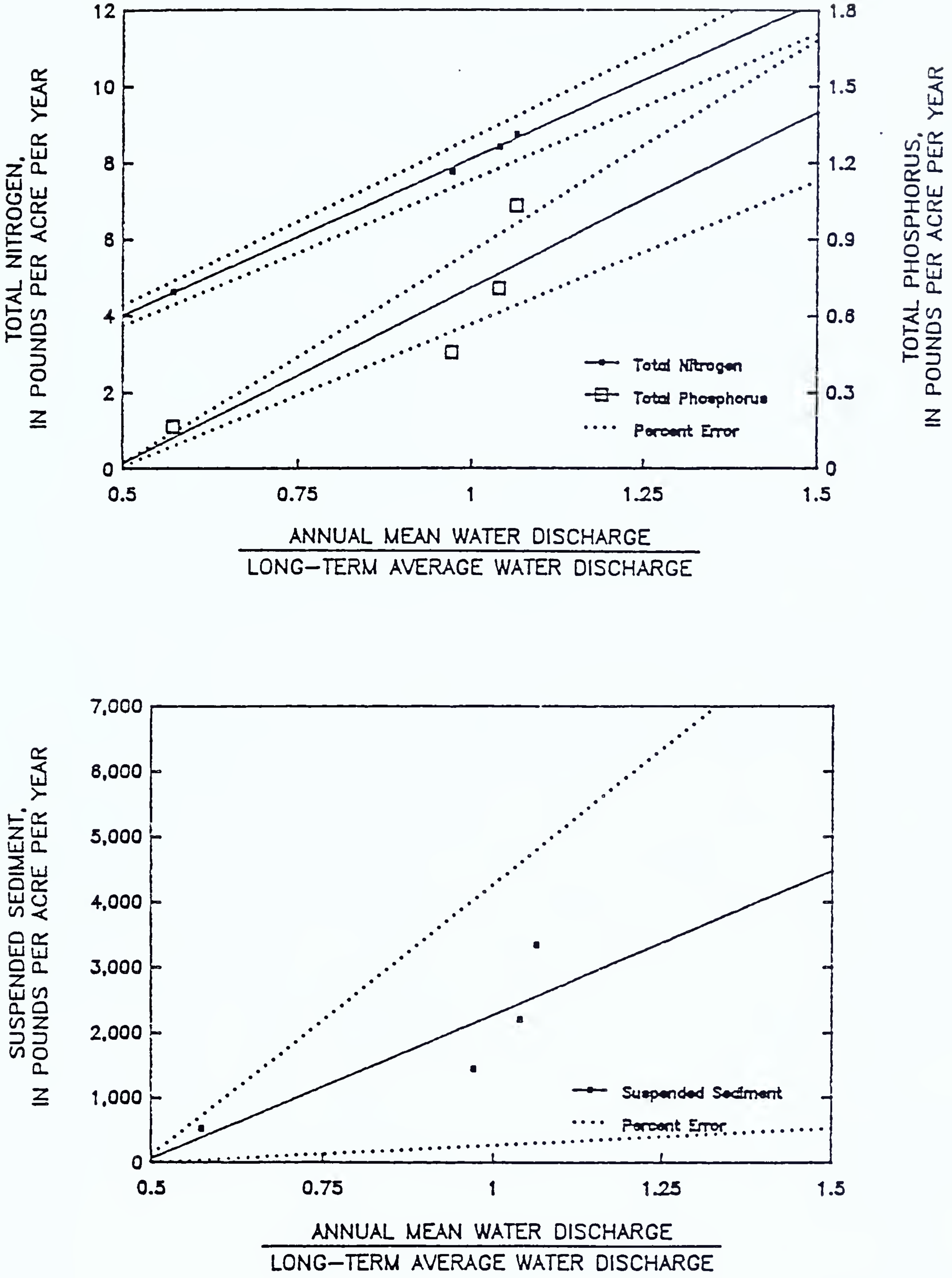
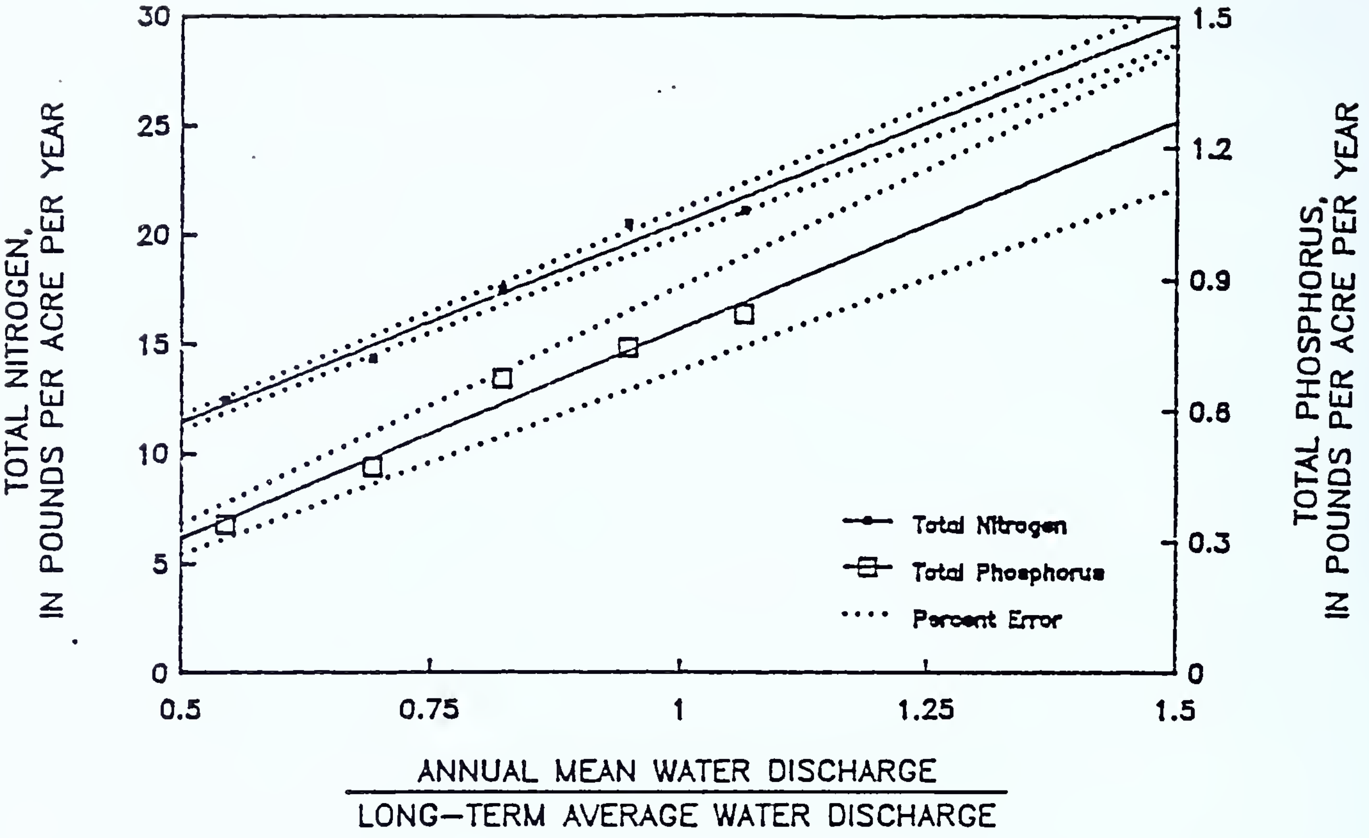


FIGURE 18.--Nutrient and suspended-sediment yields, Paxton Creek near Penbrook, Pa., 1985-88



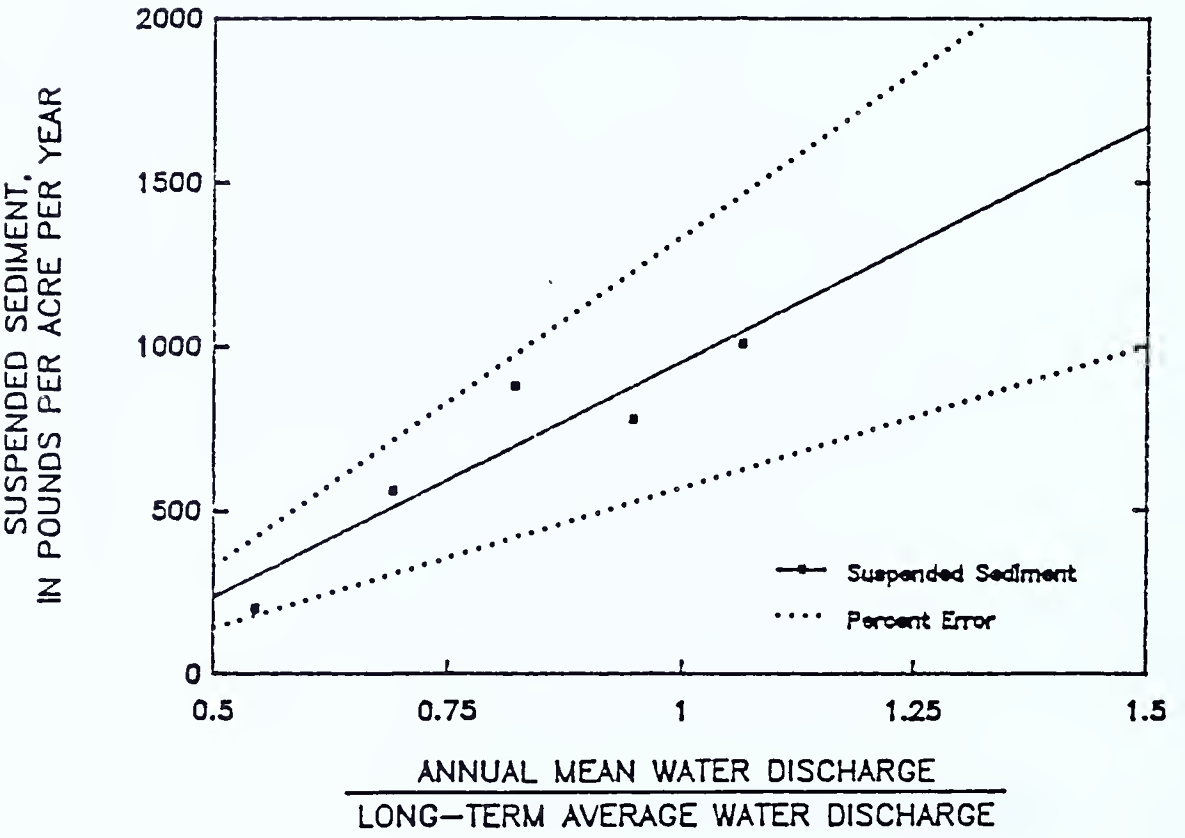


FIGURE 19.--Nutrient and suspended-sediment yields, Swatara Creek near Hershey, Pa., 1985-89

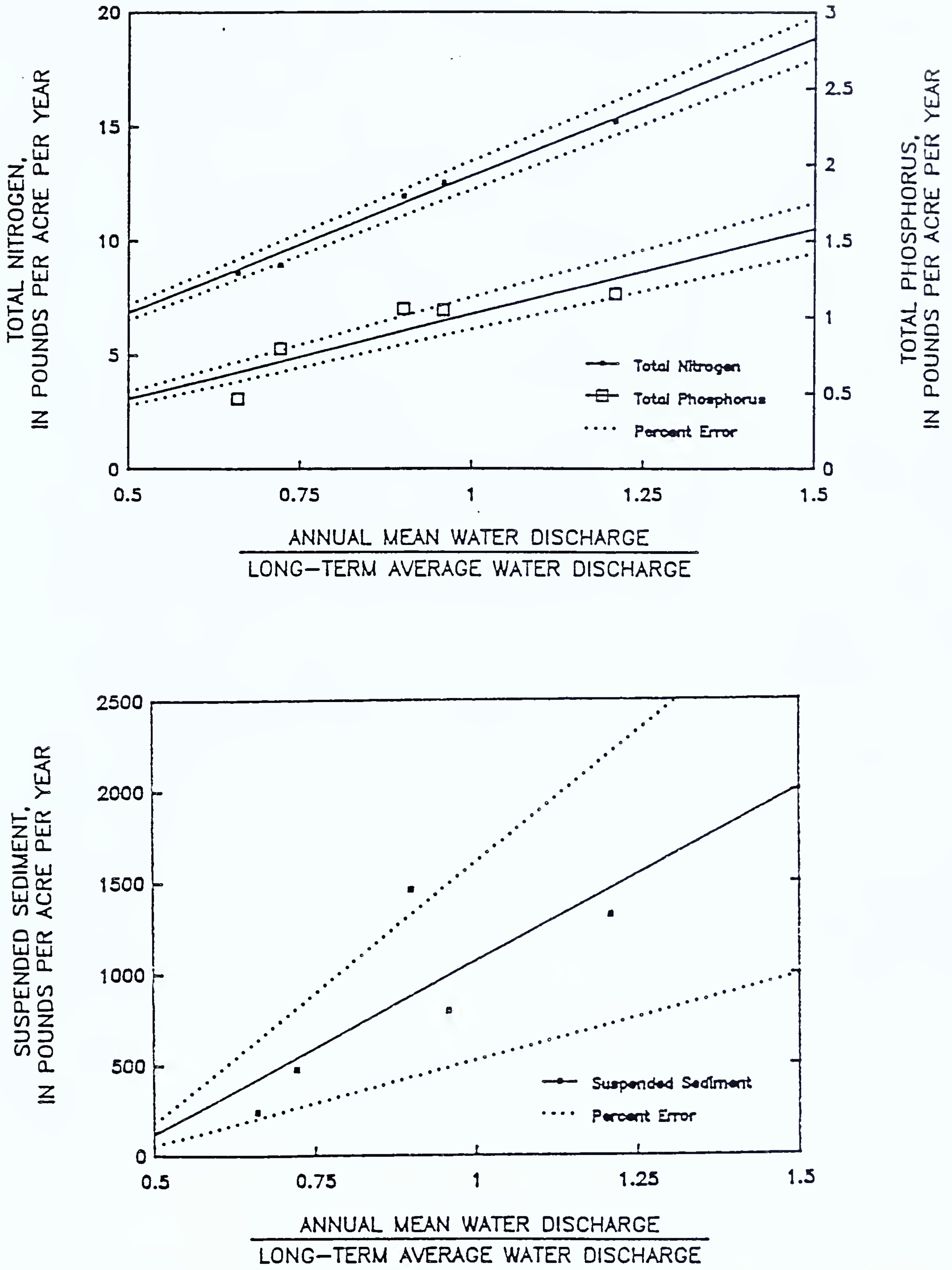
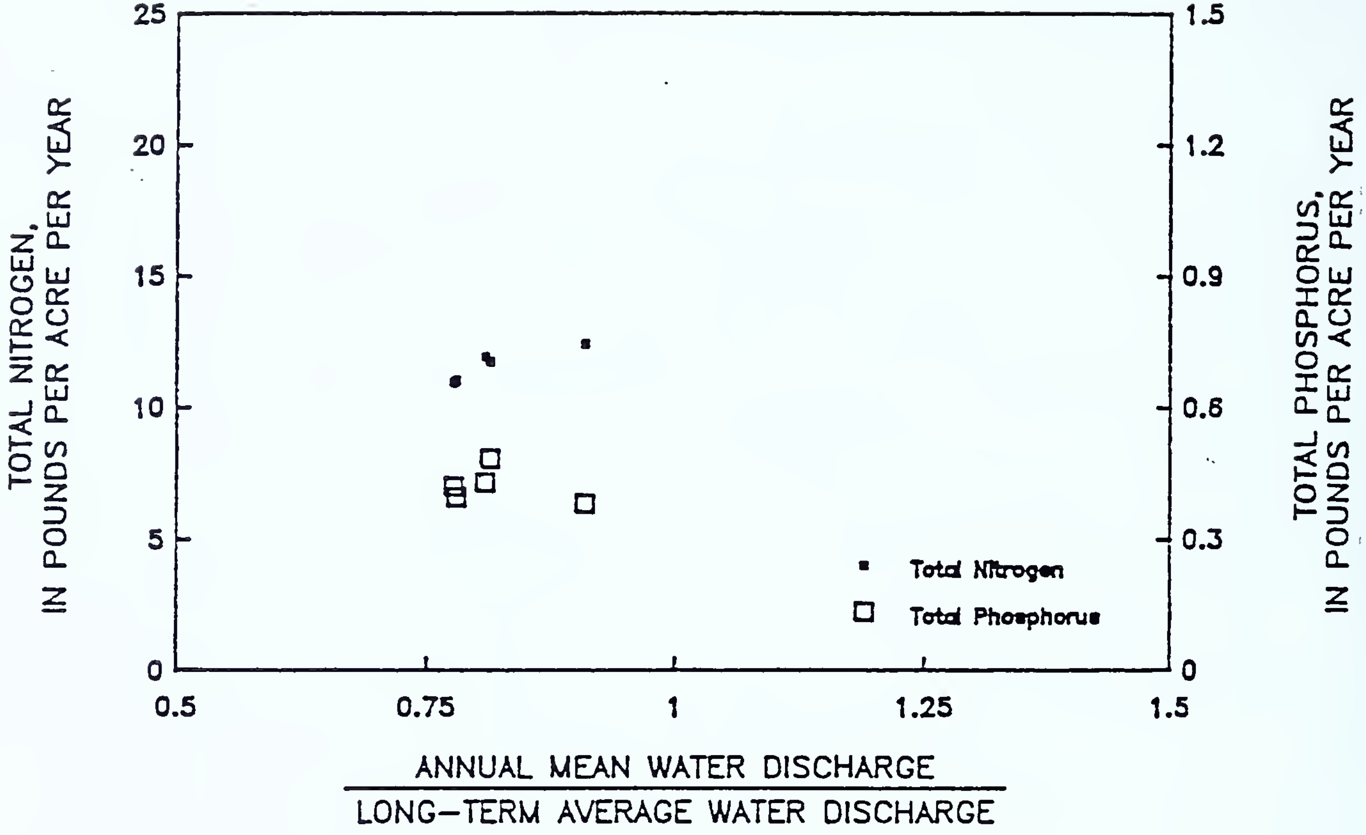


FIGURE 20.--Nutrient and suspended-sediment yields, West Conewago Creek near Manchester, Pa., 1985-89



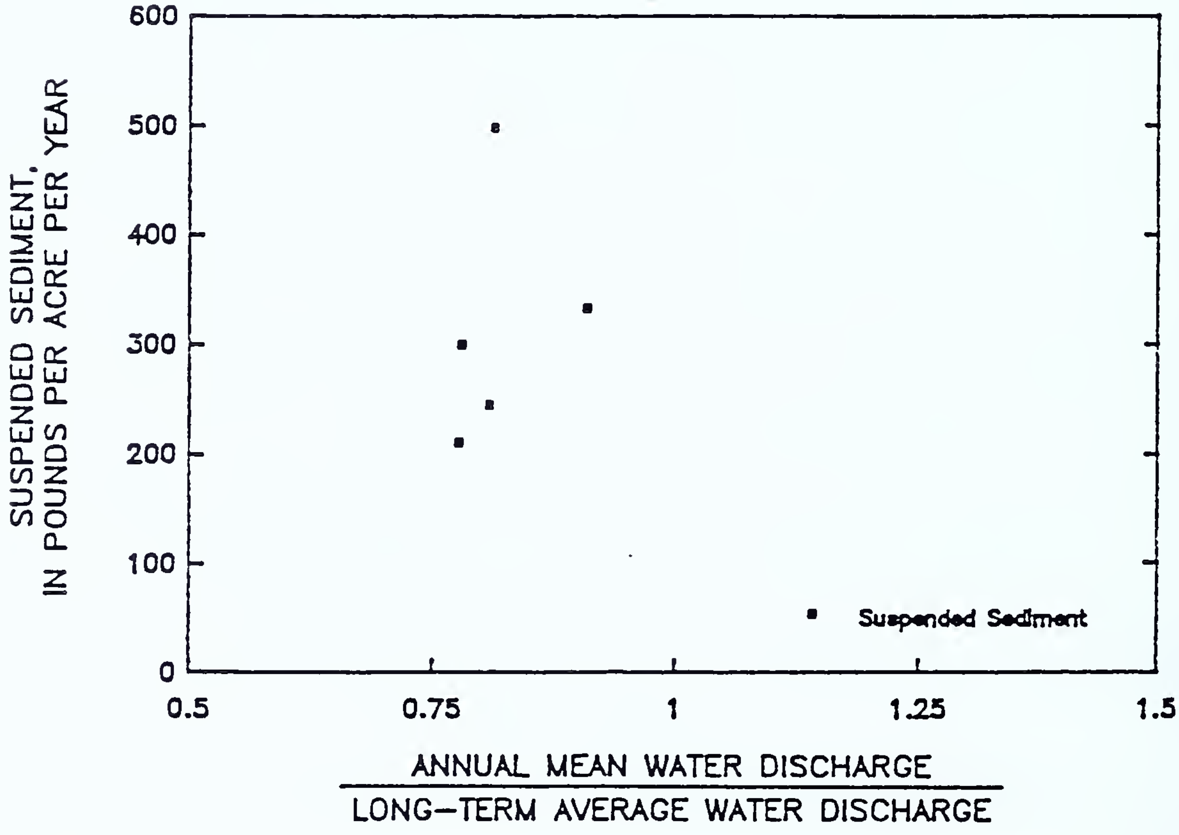
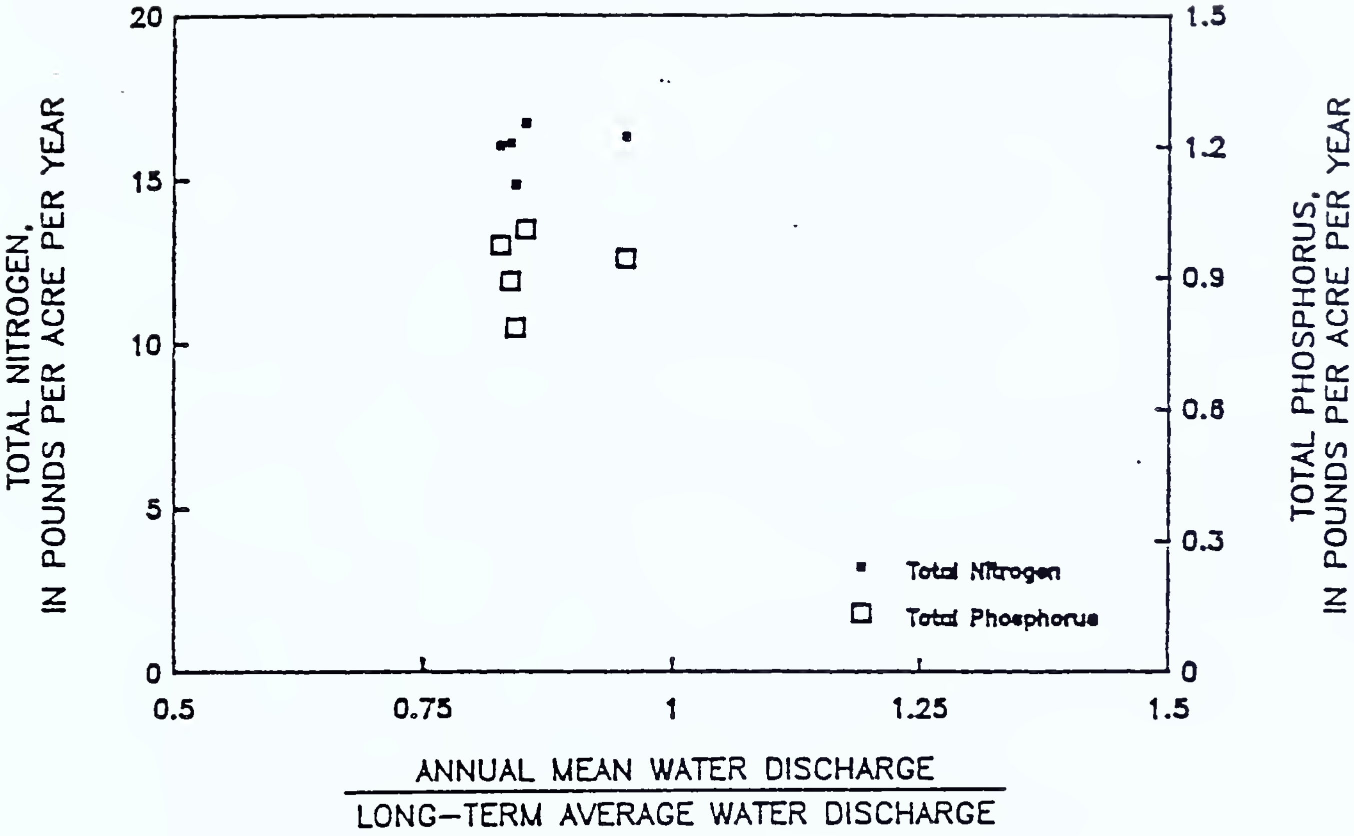


FIGURE 21.--Nutrient and suspended-sediment yields, Codorus Creek near York, Pa., 1985-89



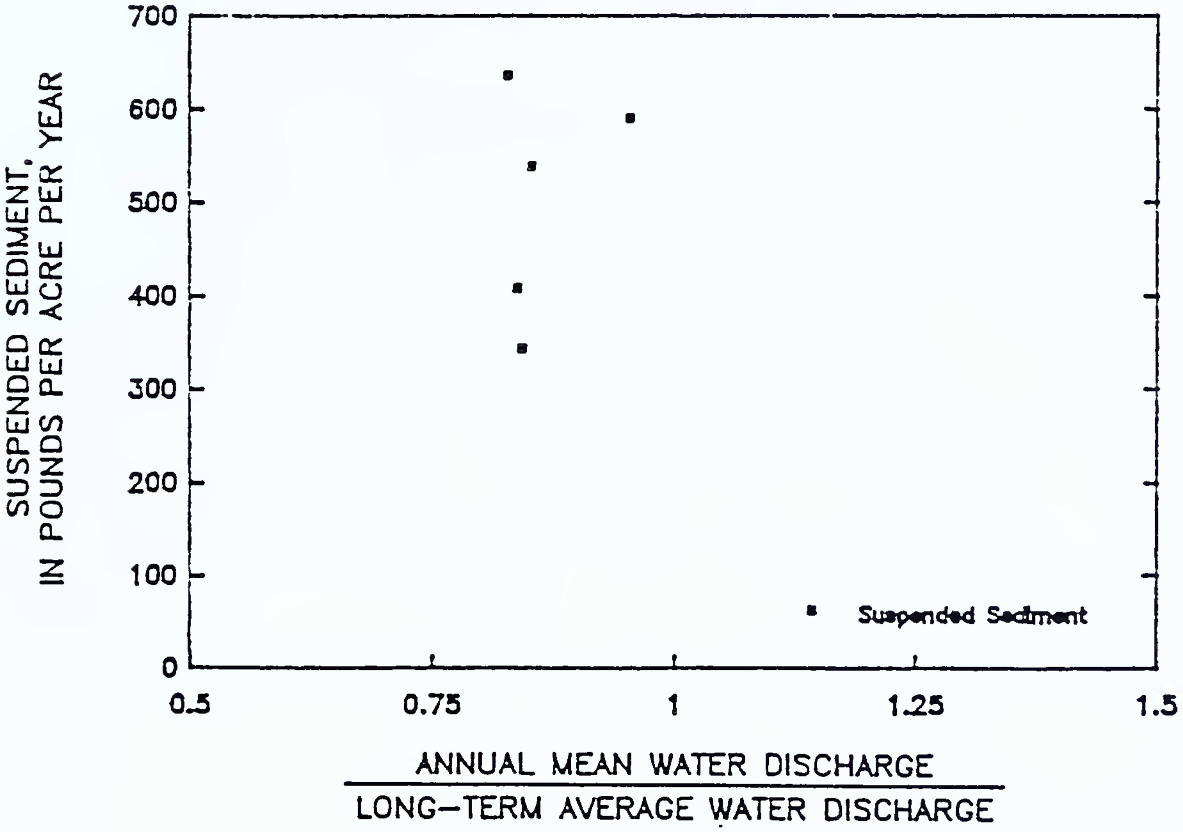
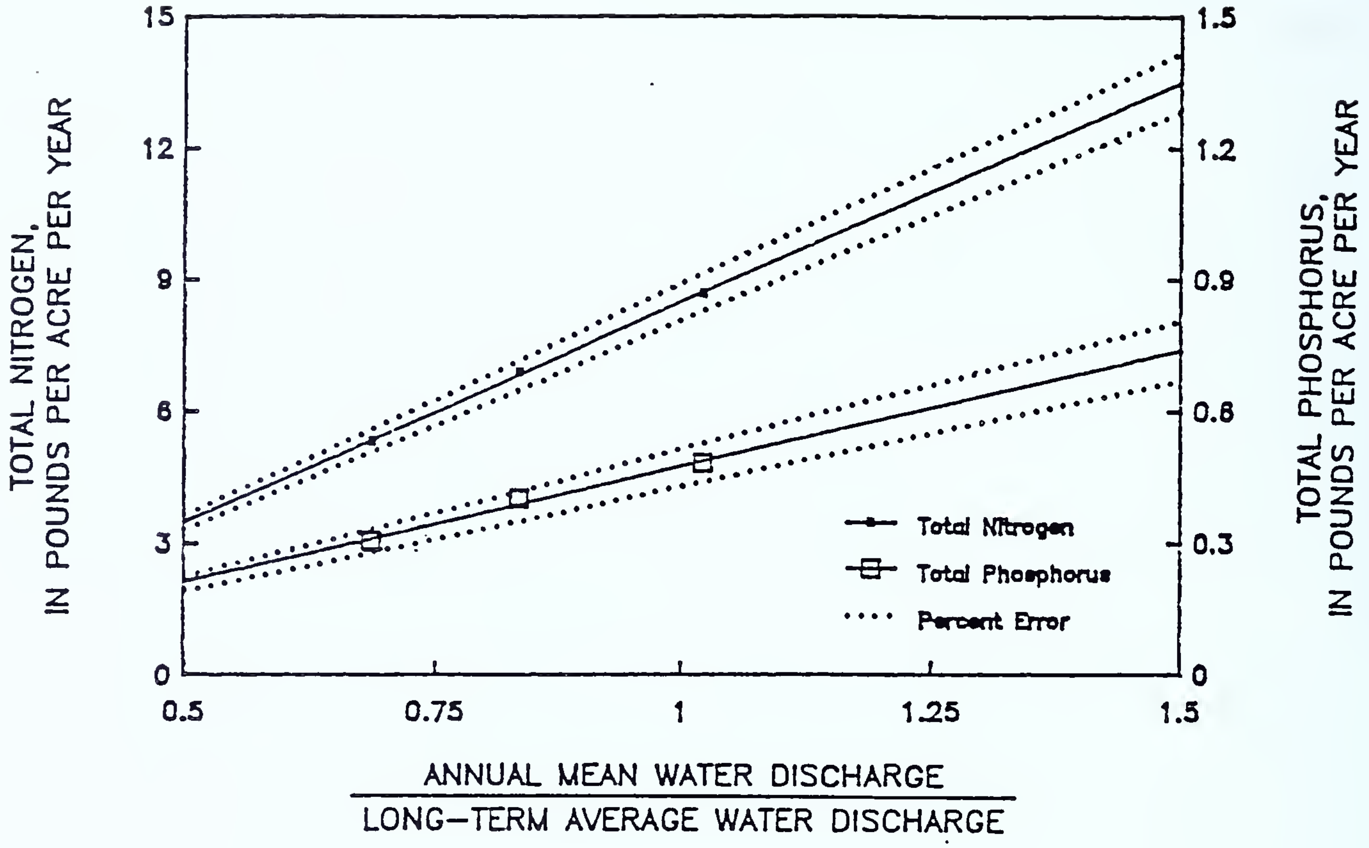


FIGURE 22.--Nutrient and suspended-sediment yields, Codorus Creek at Pleasureville, Pa., 1985-89



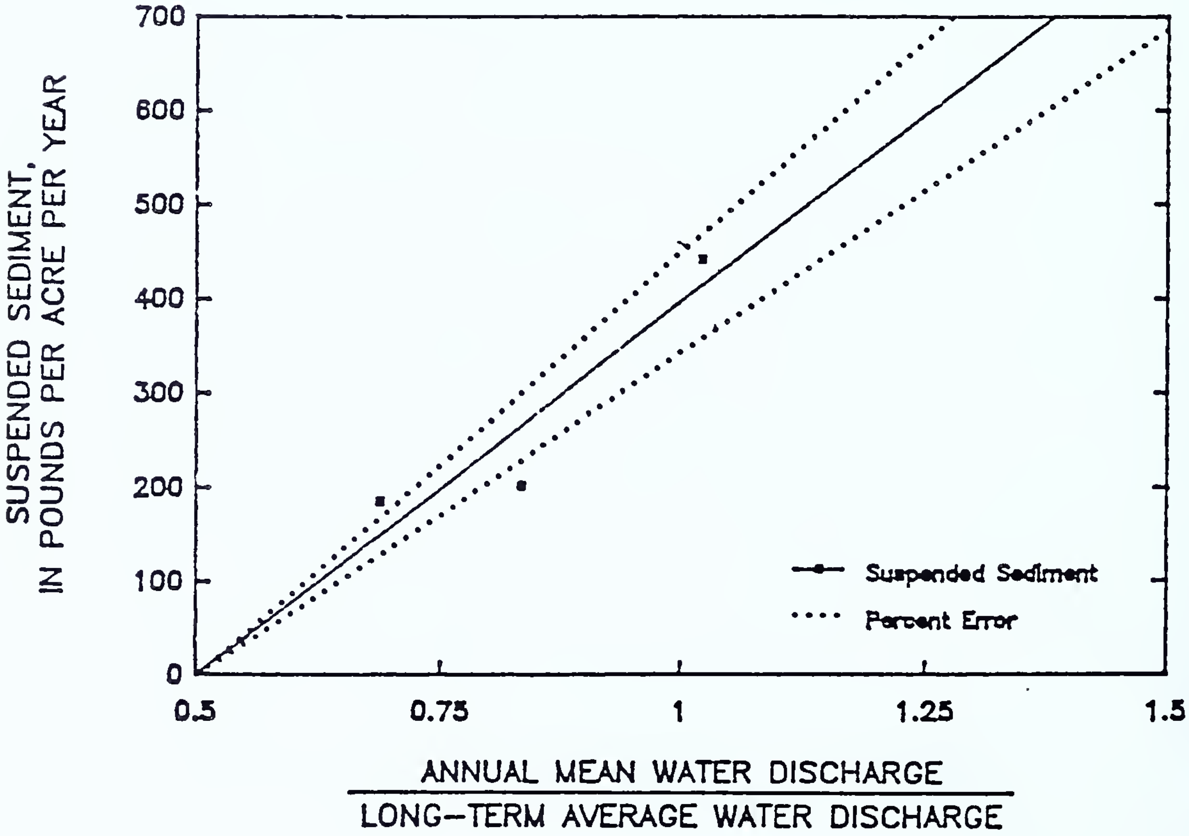


FIGURE 23.--Nutrient and suspended-sediment yields,
Susquehanna River at Marietta, Pa., 1987-89

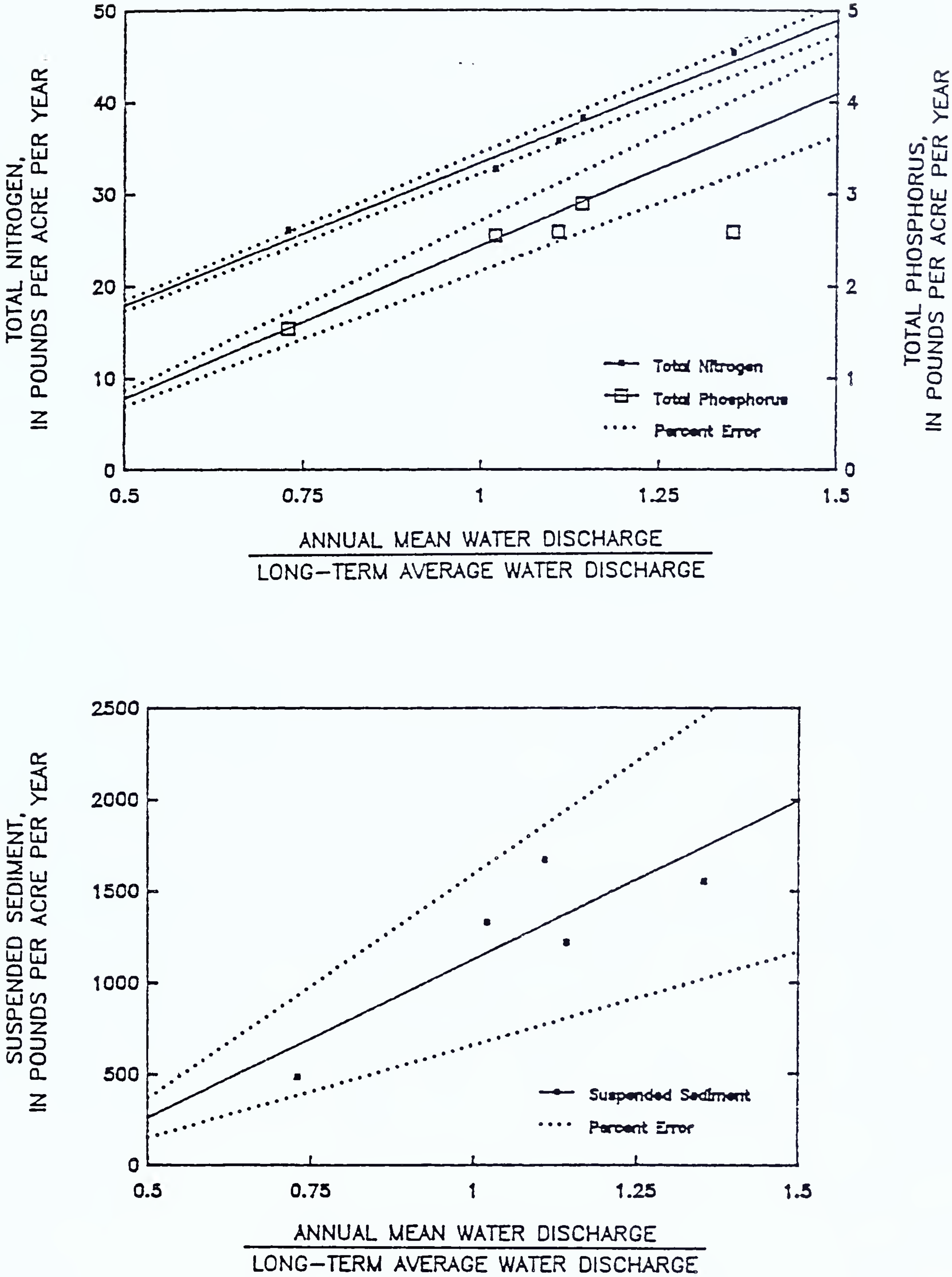
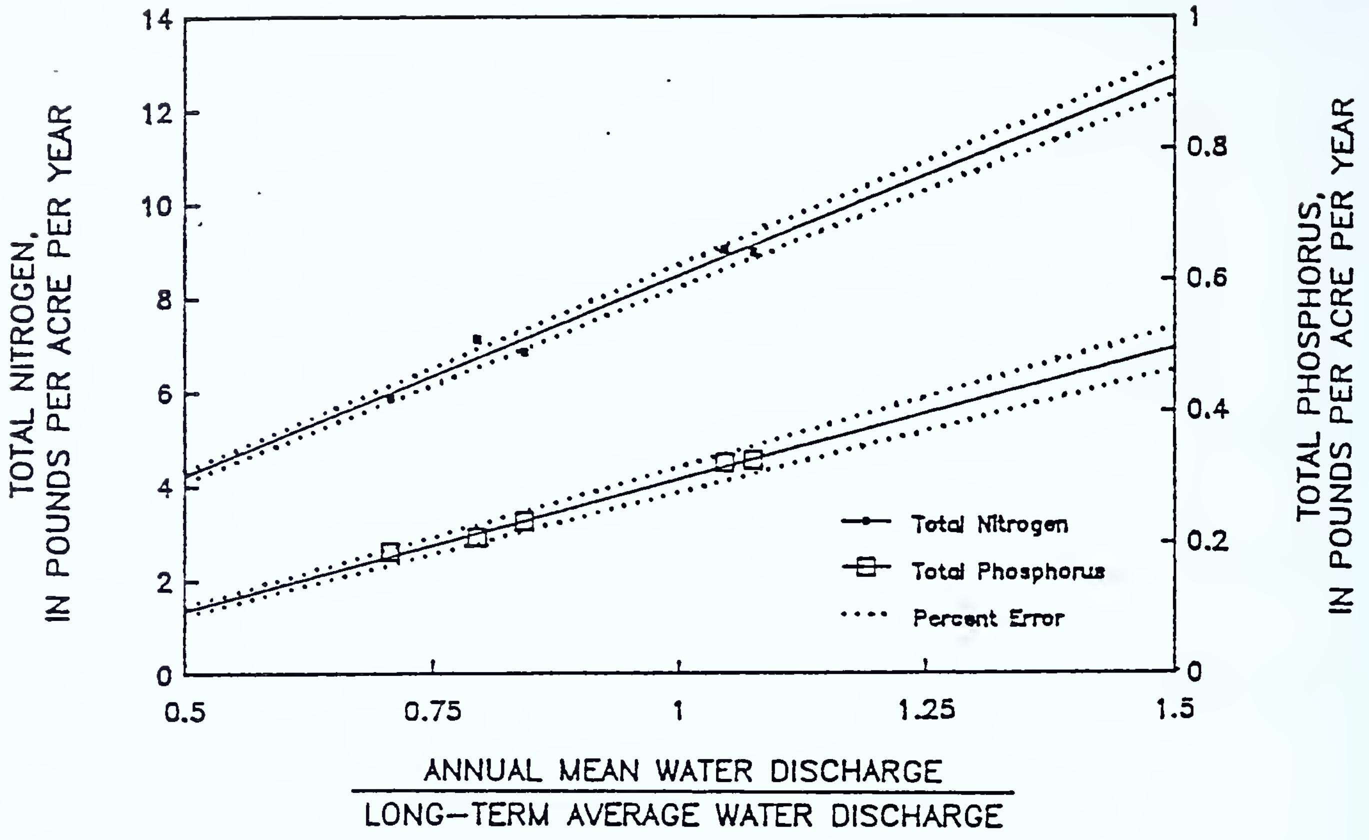


FIGURE 24.--Nutrient and suspended-sediment yields, Conestoga River at Conestoga, Pa., 1985-89



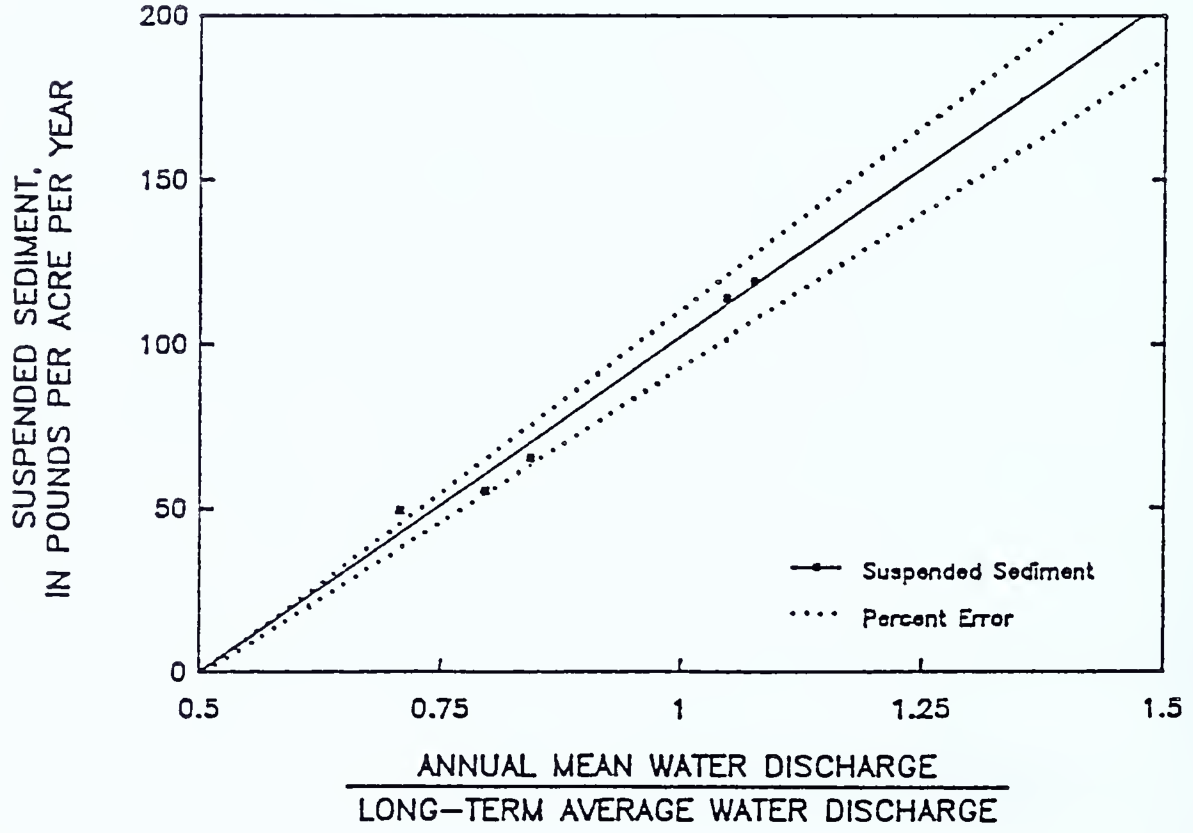


FIGURE 25.--Nutrient and suspended-sediment yields, Susquehanna River at Conowingo, Md., 1985-89

TABLE 55.--Average annual total nitrogen loads and yields, as estimated by using long-term average water discharge to adjust 1985-89 data

Site Short Name	Yield = A + B (R) A	B	Correlation Coefficient	Average Annual Load 10^6 lbs	Average Annual Yield lbs/ac
Towanda	--	--	--	32.4 1/	6.5 1/
Danville	-1.89	8.92	0.98	50.5	7.03
Renovo	.236	2.92	.98	.093	3.16
Lewisburg	-1.96	8.08	.96	26.8	6.12
Newport	-0.70	8.51	.94	16.8	7.81
Shermans Dale	-2.47	11.8	.99	1.20	9.34
Dauphin	-1.57	5.53	--	.056 2/	3.96 2/
Harrisburg	-0.68	8.06	.92	114	7.38
Penbrook	-0.10	8.22	.99	.058	8.12
Hershey	2.30	18.2	.97	6.34	20.5
Manchester	-0.82	12.0	.99	3.65	11.2
York	--	--	--	1.65 3/	11.6 3/
Pleasureville	--	--	--	2.73 3/	16.0 3/
Marietta	-1.55	10.0	.99	141	8.45
Conestoga	2.34	31.1	.98	10.1	33.4
Conowingo	-0.040	8.51	.96	147	8.47

1/ Derived by equating ratio between 1989 yields for Towanda and Danville to the ratio between annual yield at Towanda and the average annual baseline yield for Danville; i.e. $\frac{6.07}{6.56} = \frac{X}{7.03}$

2/ Derived for only 2 years of data (1985-86)

3/ Values averaged for 5 years and not adjusted with long-term average discharge

TABLE 56.--Average annual total phosphorus loads and yields, as estimated by using long-term average water discharge to adjust 1985-89 data

Site Short Name	Yield = A + B (R) A	Yield = A + B (R) B	Correlation Coefficient	Average Annual Load 10^6 lbs	Average Annual Yield lbs/ac
Towanda	--	--	--	2.08 [1]	0.418 [1]
Danville	-0.167	0.676	.97	3.66	.509
Renovo	-0.011	0.072	.66	.002	.061
Lewisburg	0.060	0.254	.94	1.38	.314
Newport	0.074	0.481	.96	1.19	.555
Shermans Dale	-0.351	0.870	.99	.066	.519
Dauphin	-0.232	0.465	--	.003 [2]	.233 [2]
Harrisburg	-0.047	0.468	.76	6.49	.421
Penbrook	-0.667	1.38	.74	.005	.713
Hershey	-0.170	0.953	.97	.242	.783
Manchester	-0.095	1.12	.76	.335	1.03
York	--	--	--	.060 [3]	.419 [2]
Pleasureville	--	--	--	.157 [3]	.918 [3]
Marietta	-0.051	0.527	.99	7.92	.476
Conestoga [4]	-0.879	3.32	.99	.734	2.44
Conowingo	-0.104	0.400	.99	5.13	.296

[1] Derived by equating ratio between 1989 yields for Towanda and Danville to the ratio between annual yield at Towanda and the average annual baseline yield for Danville; i.e. $\frac{.379}{.462} = \frac{X}{.509}$

[2] Derived for only 2 years of data (1985-86)

[3] Values averaged for 5 years and not adjusted with long-term average discharge

[4] 1985-87 data used

TABLE 57.--Average annual suspended-sediment loads and yields, as estimated by using long-term average water discharge to adjust 1985-89 data

Site Short Name	Yield = A + B (R) A	Yield = A + B (R) B	Correlation Coefficient	Average Annual Load 10^6 lbs	Average Annual Yield lbs/ac
Towanda	--	--	--	1,590 1/	318.7 1/
Danville	-496.5	888.9	0.99	2,818	392.4
Renovo	1.96	185.9	.16	5.56	187.9
Lewisburg	-157.0	345.9	.66	828	188.9
Newport	-293.3	530.2	.89	509	236.9
Shermans Dale	-770.9	1,250.5	.99	614	479.6
Dauphin	-108.8	218.2	--	1.53 2/	109.4 2/
Harrisburg	-323.7	634.9	.89	4,800	311.2
Penbrook	-2,136.0	4,409.0	.71	16.3	2,273.0
Hershey	-482.0	1,436.0	.86	295	954.0
Manchester	-826.6	1,894.3	.60	348	1,067.7
York	--	--	--	45.0 3/	316.8 3/
Pleasureville	--	--	--	85.9 3/	503.0 3/
Marietta	-396.9	793.4	.85	6,595	396.5
Conestoga	-605.7	1,733.6	.71	339	1,127.9
Conowingo	-102.1	204.4	.97	1,774	102.3

1/ Derived by equating ratio between 1989 yield for Towanda and Danville to ratio between annual yield at Towanda and the average annual baseline yield for Danville; i.e. $\frac{307}{378} = \frac{X}{392.4}$

2/ Derived for only 2 years of data (1985-86)

3/ Values averaged for 5 years and not adjusted with long-term average discharge

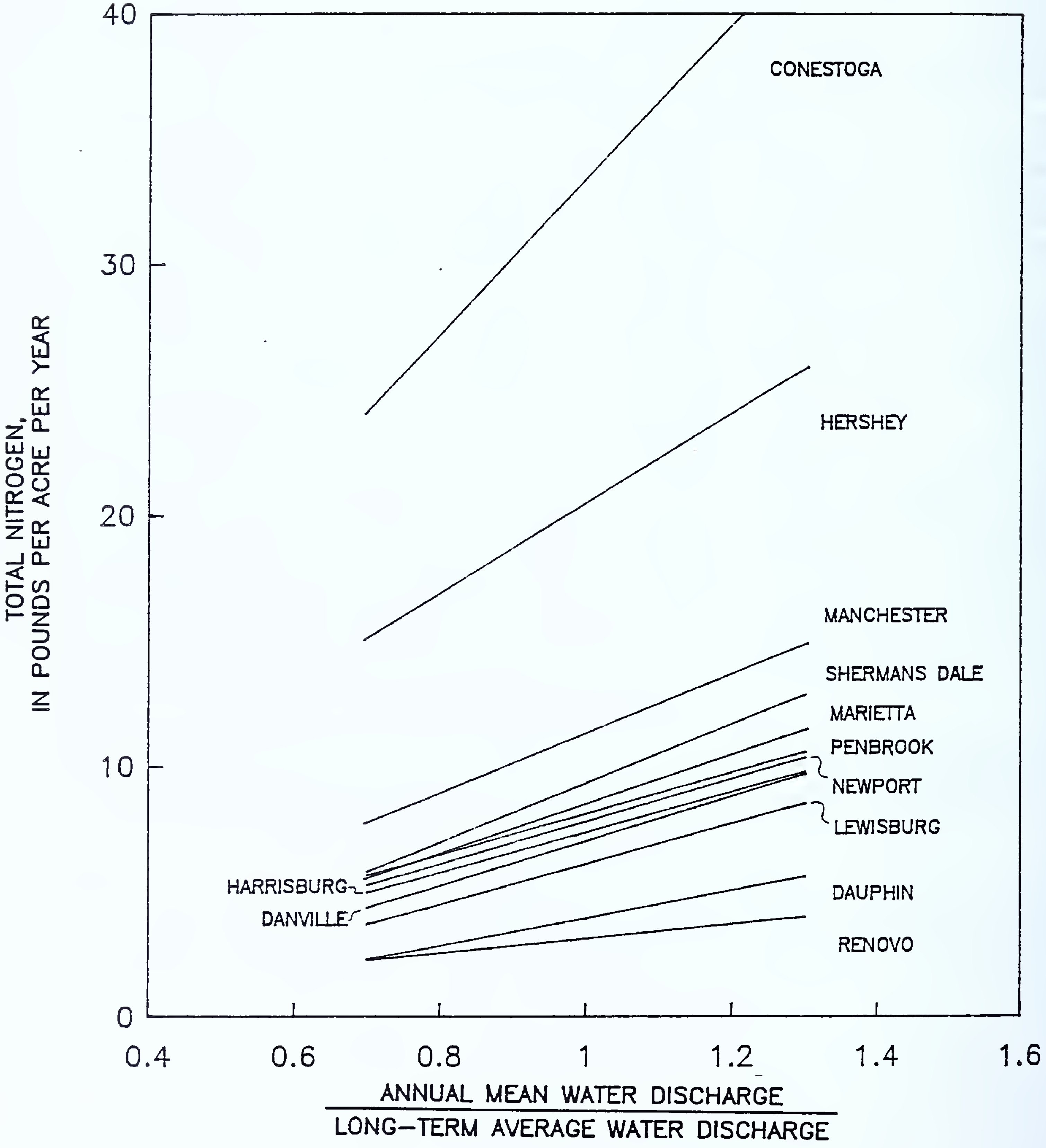


FIGURE 26.--Comparison of total nitrogen yields by sampling sites, 1985-89

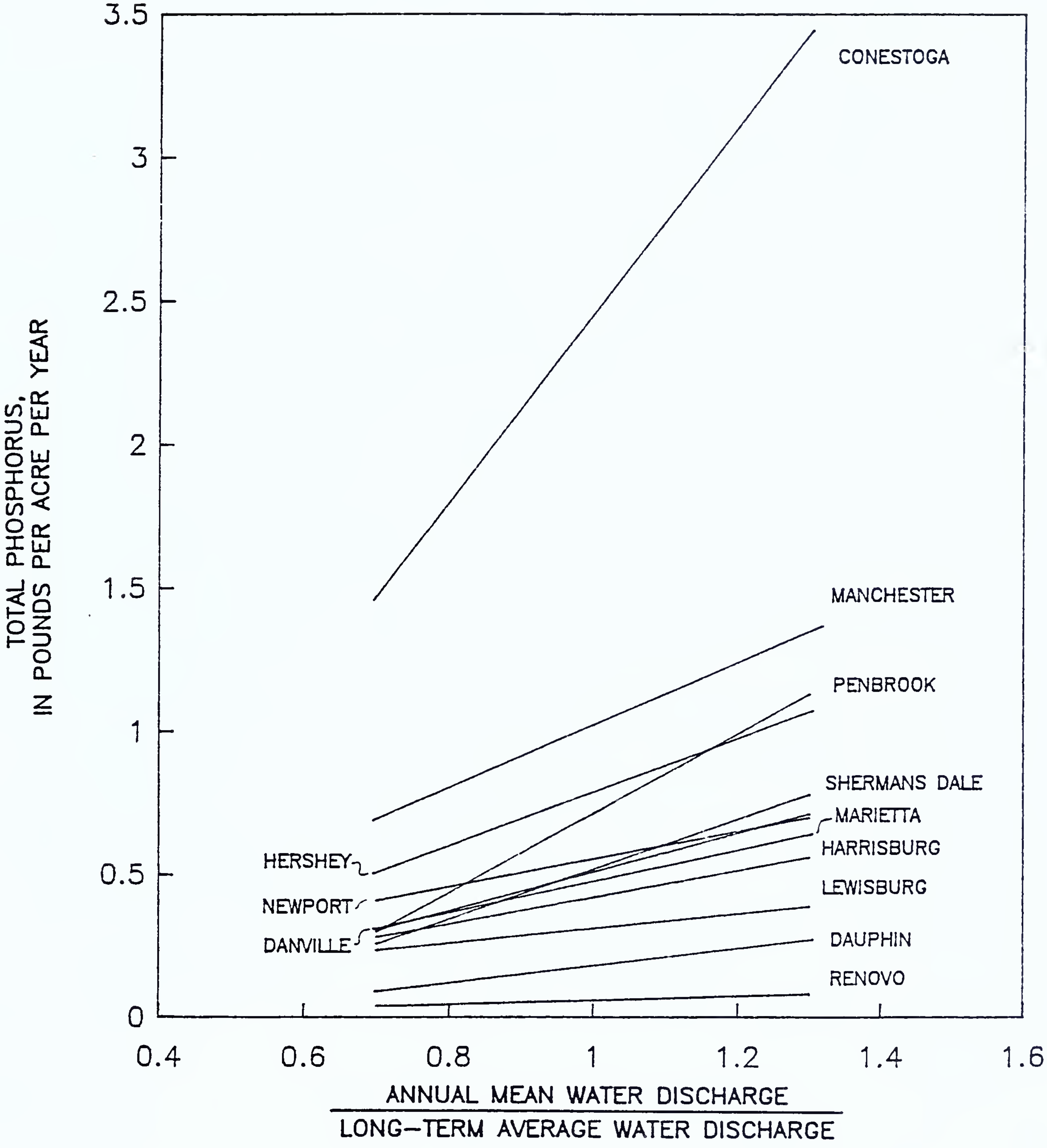


FIGURE 27.--Comparison of total phosphorus yields by sampling sites, 1985-89

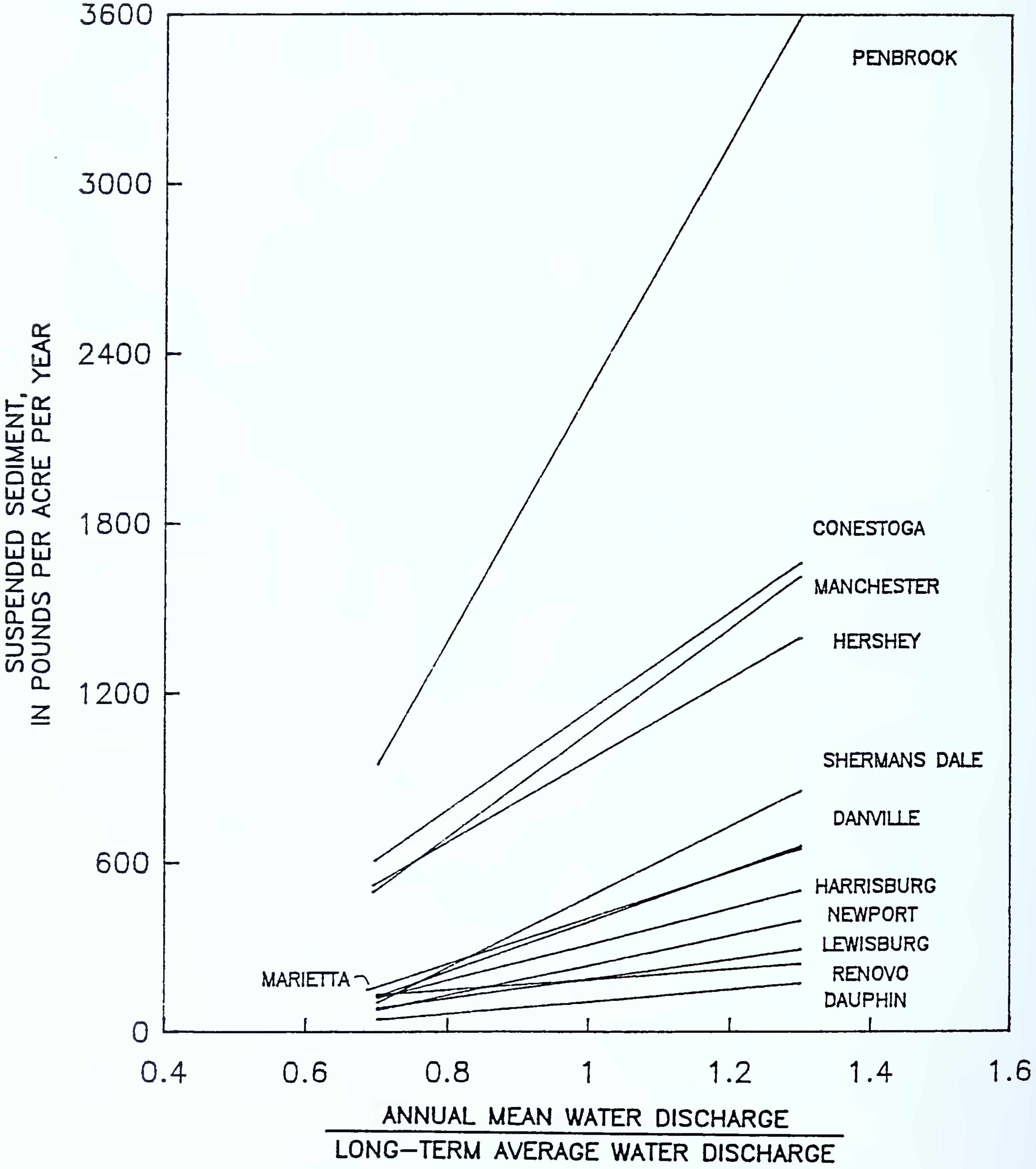


FIGURE 28.--Comparison of suspended-sediment yields by sampling sites, 1985-89

TABLE 58.--Basin categorization by land use, manure production, and average yields of total nitrogen, total phosphorus, and suspended sediment

Basin Group	Land Use: Forested	Land Use: Urban	Manure Production	Average Yield: Total Nitrogen	Average Yield: Total Phosphorus	Average Yield: Suspended Sediment
	percent		tons per acre per year	pounds per acre per year		
I	100	--	0	2.5- 5.0	.02- .25	100- 220
II	60-80	5-10	.001- .9	5 -10	.25- .60	220- 650
III	35-40	10-20	1.0 -2.0	10 -25	.60-1.2	650-1,550
IV	15	20-25	<5	<30	<1.5	<1,600

The implication of the above data is that the production of fluvial sediment in a basin increases as the forests are replaced by farms and/or urban developments. Wooded or abandoned land sustains plant growth with its "native or inherent fertility". Such land loses less nutrients and sediment to streamflow than land which has its native fertility enhanced with commercial fertilizer, animal manure, etc. However, land need not be forested to have a low nutrient loss; it can be idle land, such as a low meadow or wetland. Categorizing basins by land-use fractions is not precise. For example, the Paxton Creek basin, represented by the Penbrook sampling site, is classified as 18 percent forested, 40 percent agricultural, and 41 percent urban (Class IV in table 58). Actually, 41 percent of the watershed is a sewered, suburban/urban complex that is expanding into the other 59 percent, which is idle land. There were, during part of the sampling period, some residential areas that used septic systems. The area was almost entirely agricultural 25-30 years ago. This was the time when small amounts of low-analysis fertilizers were used; therefore, nitrogen and phosphorus residuals would not be expected to be high. The range in TP yields was therefore startling (See tables 27B and 28B). The high end of the TP yield range (1.0 lbs/ac) is high in contrast to the other basins. The suspended-sediment yields are also higher than expected. Many studies have shown the strong association between phosphorus and soil-sediment particles. Thus, it is to be expected that high sediment yields result in high TP yields. Actually, the TP yields are low in contrast to the high sediment yield. However, previous speculation was that there should be a very low fertilizer residual in the basin soils--thus, the relatively low TP yields can be considered reasonable. Also, it is known that most of the nitrogen in raw sewage is in the form of organic nitrogen and ammonia. With time, the organic nitrogen is mineralized to ammonia, which in time and in the presence of oxygen and nitrifying bacteria, oxidizes to nitrite and nitrate. For Paxton Creek, the average TN concentration was composed of 54 percent organic nitrogen plus ammonia (TKN). The TKN value for other streams believed not greatly effected by raw sewage ranges from 30-35 percent of the TN. The high sediment yields were due to construction associated with a growing urban area. These relatively high sediment yields could increase when compared to two highway construction studies in Pennsylvania (Hainly, 1980) (Reed, 1980), which measured 27,000 lbs/ac/yr and 19,000 lbs/ac/yr, respectively. Another study (Guy, 1965) of residential construction in Maryland measured 80,000 lbs/ac/yr from a 20.5 acre construction area on which 89 single homes were built over a 4-year, 9-month period.

The baseline yields of suspended sediment for Conestoga plot (figure 28) in the 35-45 percent forest, 10-20 percent urban category (Group III), but its land use is 15 percent forest and 20-25 percent urban (Group IV). This may possibly be due to the extensive sediment-control measures implemented in the Conestoga River basin. The average suspended-sediment yield at Conestoga (1,128 lbs/ac) was about one-half of the suspended-sediment yield at Penbrook (2,273 lbs/ac), but the total nitrogen and total phosphorus yields at Conestoga were 4.1 and 3.4 times higher, respectively, which was probably due to the highly fertile soils in the Conestoga River basin. Manure production in this basin, at 5.24 tons per acre per year, was the highest of any of the basins studied.

The suspended-sediment baseline for Lewisburg plotted as a 100 percent forested watershed, although table 5 shows that it is 81 percent forested and 13.9 percent in agriculture, of which 9.5 percent are tilled. This area has fairly steep, wooded slopes and its agricultural lands are mostly bottom lands that are small in area and scattered throughout the basin.

Average annual suspended-sediment yields for the periods 1962-67 and 1985-89 are presented in table 59. This is a refinement of table 54. Original data for the 1962-67 period were reported by Williams & Reed (1972).

The data in table 59 indicate that suspended-sediment yields at Danville, Lewisburg, Newport, and Harrisburg have undergone little change over the 27-year period. This suggests little or insignificant development in the upper Susquehanna River basin through the 1962-89 period. This is not surprising since, according to the U.S. Census Bureau (1964, 1980, and 1987) the population of areas such as Columbia, Lackawanna, and Luzerne Counties show a nominal loss of 1,818 inhabitants from 1960 to 1980 (<0.5 percent) and a decrease of 114,040 farmland acres between 1964 and 1987.

TABLE 59.--Annual baseline suspended-sediment yields, 1962-67 and 1985-89

	1962-67	1985-89
	pounds per acre per year	
Danville	450	390
Lewisburg	240	190
Newport	250	235
Harrisburg	345	310
Shermans Dale	265	480
Hershey	690[1]	955
Manchester	690	1,070
York	695[2]	315
Conestoga	560[3]	1,130

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[1] Measured at Harpers Tavern
[2] Based on adjustment of drainage area to 117 square miles
[3] Measured at Lancaster

In contrast, sediment yields have increased because of development, of predominately agricultural lands above the Shermans Dale, Hershey, Manchester, and Conestoga sampling sites. Among the five counties of Lancaster, York, Adams, Cumberland, and Dauphin, there was a loss of 70,430 harvested acres from 1964 to 1987. This 8-percent decrease in harvested acreage equates to 110 square miles. At about the same time (1960 to 1980), human population in these counties increased by more than 240,000.

NUTRIENT AND SUSPENDED-SEDIMENT LOADS INPUT TO RESERVOIRS ON THE LOWER SUSQUEHANNA RIVER AND RESERVOIR OUTPUT AT CONOWINGO, MD

The nutrient and suspended-sediment loads measured at Conowingo Dam do not reflect total basin loads transported to the reservoirs by the Susquehanna River and its tributaries. Total-basin loading inputs to the reservoirs were estimated, for comparative purposes, from loads measured at the sample sites.

The estimates of TN, TP, and suspended-sediment loads transported to the reservoirs by the Susquehanna River and its tributaries are presented in tables 60, 61, and 62, respectively. TN, TP, and sediment load estimates for each of the years, 1985 through 1989, were made by adding the loads transported by the Susquehanna River at Harrisburg, loads of the sampled tributaries below Harrisburg, and load estimates for the unmeasured tributaries downstream of Harrisburg. Alternate estimates of TN, TP, and sediment basin loads were made for the period 1987-89 using measurements for the Susquehanna River at Marietta, the Conestoga River, and estimates for the remaining 2 percent of the unsampled drainage area downstream from Marietta. These load estimates are shown on the same tables. The sampling site on the Susquehanna River at Marietta is the southern-most station upstream from the reservoirs. Its records are believed to be better suited than those for Harrisburg for estimating basin loads, because it reduced errors in data collection and load estimation. This site was sampled only during the period 1987-89, so its load information is useful for only gross comparisons.

Comparative values of estimated yearly basin loads and the loads measured at Conowingo Dam for 1985-89 are presented in table 63. The load values are taken from tables 60-62. The yearly differences in the basin and Conowingo loads are the quantities of TN, TP, and suspended sediment trapped in the reservoirs. The loads at Conowingo Dam were calculated by using data collected during 1985-89. The annual basin loads computed with Marietta as the main stem site are also shown.

As mentioned in the previous section, the loads vary from year-to-year, depending mostly on water discharge. The loads need to be related to a common base in order to make legitimate year-over-year comparisons for the same site, or to make comparisons among sites. Therefore, the methodology described in

TABLE 60.--Estimated annual total nitrogen loads for the Susquehanna River basin, 1985-89

	Drainage Area		1985		1986		1987		1988		1989	
	Gage	Mouth	Yield	Load	Yield	Load	Yield	Load	Yield	Load	Yield	Load
	mi^2		lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs
Harriburg		24,100		93,100		121,100		87,000		69,800		106,000
Paxton	11.2	27.4	2,957	80	5,389	150	5,600	150	4,960	130		(est)150[1]
Swatara	483	571	7,936	4,530	13,120	7,490	11,136	6,360	9,152	5,230	13,504	7,710
Conestoga	470	477	16,640	7,940	24,512	11,690	20,928	9,980	22,912	10,930	29,056	13,860
Pequea		154	16,640	2,560	24,512	3,770	20,928	3,220	22,912	3,530	29,056	4,470
Chickies		126	16,640	2,100	24,512	3,090	20,928	2,640	22,912	2,890	29,056	3,660
East Shore		196	12,288	2,410	12,916	2,530	16,032	3,140	16,032	3,140	21,280	4,170
Subtotal		25,651		112,720		149,720		112,490		95,650		140,020
W Conewago	510	515	5,286	2,720	8,000	4,120	7,616	3,920	5,478	2,820	9,728	5,010
Codorus[2]	267	278	9,472	3,480	10,304	3,710	10,688	3,820	10,240	3,700	10,432	3,750
West Shore		656	7,379	4,840	9,152	6,000	9,152	6,000	7,859	5,160	10,080	6,610
Subbtotal		1,449		11,040		13,380		13,740		11,680		15,370
BASIN TOTAL		27,100		123,760		163,550		126,230		107,330		155,390
CONOWINGO TOTAL		27,100		123,190		155,660		118,480		101,650		156,670
Marietta		25,990						114,000		88,300		144,000
Conestoga	470	477					20,928	9,980	22,912	10,930	29,056	13,860
Pequea		154					20,928	3,220	22,912	3,530	29,056	4,470
East Shore		86					16,032	1,380	16,032	1,380	21,280	1,830
West Shore		393					9,152	3,600	7,859	3,090	10,080	3,960
BASIN TOTAL		27,100						132,180		107,230		168,120
CONOWINGO TOTAL		27,100						118,480		101,650		168,670

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[1] Used the 1987 calendar year load because rainfall in 1989 was similar to that of 1987

[2] Includes 850 x 10^3 lbs TP from Springettsbury Township STP (35 mg/l at 8 mgd)

TABLE 61.--Estimated annual total phosphorus loads for the Susquehanna River basin, 1985-89

	Drainage Area		1985		1986		1987		1988		1989	
	Gage	Mouth	Yield	Load	Yield	Load	Yield	Load	Yield	Load	Yield	Load
	mi^2		lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs
Harriburg		24,100		3,540		7,320		5,540		4,000		5,460
Paxton	11.2	27.4	106	3	451	12	659	18	291	8		(est) 18[1]
Swatara	483	571	216	123	473	270	428	244	299	171	522	298
Conestoga	470	477	979	467	1,850	882	1,626	775	1,651	788	1,651	788
Pequea		154	979	151	1,850	285	1,626	250	1,651	254	1,651	254
Chickies		126	979	123	1,850	233	1,626	205	1,651	208	1,651	208
East Shore		196	597	117	1,161	228	1,026	201	975	191	1,087	213
Subtotal		25,651		4,524		9,230		7,233		5,620		7,239
W Conewago	510	515	505	260	666	343	672	346	296	153	736	379
Codorus[2]	267	278	502	188	570	208	641	227	623	222	603	217
West Shore		656	503	330	618	405	656	431	460	301	669	439
Subbtotal		1,449		778		956		1,004		676		1,035
BASIN TOTAL		27,100		5,302		10,186		8,237		6,296		8,274
CONOWINGO TOTAL		27,100		3,596		5,620		4,012		3,204		5,548
Marietta		25,990						6,650		5,060		8,020
Conestoga	470	477					1,626	775	1,651	788	1,651	788
Pequea		154					1,626	250	1,651	254	1,651	254
East Shore		86					1,026	88	975	84	1,087	93
West Shore		393					656	258	460	181	669	263
BASIN TOTAL		27,100						8,021		6,367		9,418
CONOWINGO TOTAL		27,100						4,012		3,204		5,548

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[1] Used the 1987 calendar year load because rainfall in 1989 was similar to that of 1987

[2] Includes 49 x 10^3 lbs TP from Springettsbury Township STP (2 mg/l at 8 mgd)

TABLE 62.--Estimated annual total suspended-sediment loads for the Susquehanna River basin, 1985-89

	Drainage Area		1985		1986		1987		1988		1989	
	Gage	Mouth	Yield	Load	Yield	Load	Yield	Load	Yield	Load	Yield	Load
	mi^2		lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs	lb/mi^2	10^3 lbs
Harriburg		24,100		2,040,000		5,690,000		2,950,000		2,050,000		4,090,000
Paxton	11.2	27.4	339,840	9,210	1,414,400	38,330	2,144,000	58,100	921,600	24,980		(est)
58,100[1/]												
Swatara	483	571	126,720	72,360	497,920	284,310	563,840	321,950	357,760	204,280	697,600	398,330
Conestoga	470	477	309,120	147,450	780,800	372,440	851,200	406,020	1,068,800	509,820	992,000	473,180
Pequea		154	309,120	47,600	780,800	120,240	851,200	131,080	1,068,800	164,600	992,000	152,770
Chickies		126	309,120	38,950	780,800	98,380	851,200	107,250	1,068,800	134,670	992,000	124,990
East Shore		196	217,928	42,710	639,360	125,310	707,520	138,670	713,280	139,800	844,800	165,580
Subtotal		25,651.4		2,398,280		6,729,010		4,113,070		3,228,150		5,462,950
W Conewago	510	515	303,360	156,230	510,080	262,690	934,400	481,220	153,600	79,100	844,800	435,070
Codorus	267	278	219,520	61,030	261,120	72,590	344,960	95,900	407,040	113,160	376,960	104,790
West Shore		656	261,440	171,500	385,600	252,950	639,680	419,630	280,320	183,890	610,880	400,740
Subbtotal		1,449		388,760		588,230		996,750		376,150		940,600
BASIN TOTAL		27,100		2,787,040		7,317,240		5,109,820		3,604,300		6,403,550
CONOWINGO TOTAL		27,100		958,000		2,060,000		1,130,000		856,000		1,980,000
Marietta		25,990						3,350,000		3,070,000		7,360,000
Conestoga	470	477					851,200	406,020	1,068,800	509,820	992,200	473,180
Pequea		154					851,200	131,080	1,068,800	164,600	992,000	152,770
East Shore		86					707,520	60,850	713,280	61,340	844,800	72,650
West Shore		393					639,680	251,390	280,320	110,170	610,880	240,080
BASIN TOTAL		27,100						4,199,340		3,915,950		8,298,680
CONOWINGO TOTAL		27,100						1,130,000		856,000		1,980,000

[1/] Used the 1987 calendar year load because rainfall in 1989 was similar to that of 1987

TABLE 63.--Nutrient and suspended-sediment loads input to reservoirs and output at Conowingo, 1985-89

	Total Nitrogen					Total Phosphorus					Suspended Sediment				
	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989
								millions of pounds							
INPUT--															
Harrisburg and tributaries	124	164	126	107	155	5.3	10.2	8.2	6.3	8.3	2,790	7,320	5,110	3,600	6,400
OUTPUT--															
Conowingo	123	156	118	102	157	3.6	5.6	4.0	3.2	5.5	958	2,060	1,130	856	1,980
Trapped	1	8	8	5	-2	1.7	4.6	4.2	3.1	2.8	1,832	5,260	3,980	2,744	4,420
ALTERNATE INPUT--*															
Marietta and tributaries			132	107	168			8.0	6.4	9.4			4,200	3,920	8,300

* Shown for comparison with input computed form measurements made at Harrisburg and other downstream sites; loads not used in calculating nutrients and sediments trapped in the reservoirs

the previous section was used to determine average baseline loads from the TN, TP, and sediment loads shown in tables 60, 61, and 62, and the corresponding water-discharge ratios of 0.795, 1.076, 0.842, 0.707, and 1.047 for 1985-89, respectively.

The following TN, TP, and suspended-sediment relations for average annual load were developed for the basin and Conowingo:

Basin loads input to lower Susquehanna River reservoirs:

TN $Y = 6.02 \times 10^6 + 144 \times 10^6 (R)$

TP $Y = -1.02 \times 10^6 + 9.72 \times 10^6 (R)$

Sediment $Y = -4{,}500 \times 10^6 + 10{,}680 \times 10^6 (R)$

Conowingo loads output to Susquehanna River below reservoirs:

TN $Y = -0.692 \times 10^6 + 148 \times 10^6 (R)$

TP $Y = -1.80 \times 10^6 + 6.93 \times 10^6 (R)$

Sediment $Y = -1{,}770 \times 10^6 + 3{,}550 \times 10^6 (R)$

Long-term (baseline) annual loads, computed by using R=1, are shown in table 64. In order to estimate the Pennsylvanian contribution to basin load, the loads generated in New York must be deducted from the basin total. Average annual loads of TN, TP, and suspended sediment from New York were estimated by using the estimated annual yields for Towanda, as shown in tables 56, 57, and 58, and the drainage area in New York. These loads also are shown in table 64.

The trapped nitrogen is of minor significance when considering the entire nitrogen load from the basin, but the trapped phosphorus and sediment are highly significant. The computed long-term annual basin load of $6{,}180 \times 10^6$ pounds of sediment compares favorably with the average annual sediment load of $6{,}000 \times 10^6$ pounds reported by Williams and Reed (1972). The

TABLE 64.--Annual baseline loads of nutrients and suspended sediment (Based on loads measured in the period, 1985-89 and adjusted to long-term averages)

	Total Nitrogen	Total Phosphorus	Suspended Sediment
	millions of pounds per year		
New York's contribution	26	1.60	1,280
Pennsylvania's contribution	124	7.10	4,900
TOTAL FROM BASIN	150	8.70	6,180
Conowingo's output to Chesapeake Bay	147	5.13	1,780
Trapped in reservoirs of lower Susquehanna River	3	3.57	4,400

post-1960's increase in suspended-sediment load can be accounted for by changes in subbasin yields, as shown in table 59 of the previous section. Based on the average annual load computed for Conowingo, 4,400 x 10^6 pounds or 71 percent of the average annual sediment input to the reservoirs is entrapped. Lang (1982) reported that 4,600 x 10^6 pounds of suspended sediment were measured at Harrisburg and 2,450 x 10^6 pounds were measured in the same period at Conowingo. These figures indicate that 45 percent of the suspended sediment was being trapped in the reservoirs during this reporting period. However, his percentage of trapped suspended sediment would have been greater if loads from the areas below Harrisburg were taken into account. Williams and Reed (1972) reported an average annual entrapment of 2,400 x 10^6 pounds of sediment. The nutrients and sediment being trapped in the reservoirs are subject to be resuspended by unusually high streamflows. It is believed that the total basin loads, rather than the Conowingo loads, should be used to evaluate Best Management Practices.

It was mentioned earlier that the sampling station on the Susquehanna River at Marietta may be better suited for estimating basin loads. The data collected at Marietta during 1987-89 also were used to calculate the long-term average annual load. Those loads are shown below for comparison with the 5-year baseline average loads for the basin and for Conowingo. The average annual baseline loads for the basin for the two monitoring periods are very similar.

TABLE 65.--Comparison of two estimates of annual baseline loads for the basin with baseline loads at Conowingo, Md.

	Total Nitrogen	Total Phosphorus	Suspended Sediment
	millions of pounds per year		
Load from basin, 1985-89 [1/]	150	8.70	6,180
Load from basin, 1987-89 [2/]	153	8.74	6,820
Load from Conowingo, 1985-89	147	5.13	1,780

[1/] Harrisburg as main-stem monitoring site
[2/] Marietta as main-stem monitoring site

SUMMARY AND CONCLUSIONS

Excessive nutrients and sediments are suspected of causing a marked decrease in the productivity of the Chesapeake Bay, and much of the excess nutrients and sediment are thought to come from the lower Susquehanna River basin. Annual loads of nutrients and suspended sediment transported by the main stem of the Susquehanna River and ten tributaries were measured from 1985 to 1989 to determine a baseline loading rate for the basin.

Data were collected monthly during base-flow conditons and during one storm event per season.

Nutrient and suspended-sediment data were collected from the Susquehanna River at Danville, from the West Branch Susquehanna River at Lewisburg, and from six of the major tributaries to the lower Susquehanna River basin--Juniata River, Sherman Creek, Swatara Creek, West Conewago Creek, Codorus Creek at Pleasureville, and the Conestoga River. In addition, data were collected from: Stony Creek at Water Tank Trail near Dauphin, which is in a completely forested basin; Susquehanna River at Harrisburg; Paxton Creek, which has a partly sewered urban basin; and Codorus Creek at York. The area between the stations on the Codorus Creek at York and at Pleasureville is mostly urban and contains one large sewage-treatment plant. Data also were collected from the Susquehanna River at Conowingo by the Towson, Maryland, Office of the U.S. Geological Survey. The loads and yields calculated from that data for the 1985-89 period are included in this report. Annual loads and yields from Young Womans Creek, a 100 percent forested basin located in north-central Pennsylvania, near Renovo, are included represents another undisturbed area.

Base-flow discharge and concentrations of nutrients and suspended sediment varied seasonally. Generally, base-flow discharge was highest during winter and lowest during summer at all sites. However, relations between base-flow discharge and concentrations of nutrients and suspended sediment varied from site-to-site.

Base-flow nitrite plus nitrate, ammonia, and total nitrogen concentrations at Danville were highest during winter and lowest during summer. Concentrations of total organic nitrogen and dissolved and total phosphorus were highest in spring, and were often coincident with high suspended-sediment concentrations. Seasonal variations in Shermans Creek at Shermans Dale differed from those observed at Danville, except for nitrite plus nitrate. Concentrations of total ammonia, total organic nitrogen, dissolved and total phosphorus, and suspended-sediment concentrations were highest during summer.

Base-flow nitrite plus nitrate concentrations at the other main-stream sites also were highest in winter and lowest in summer, except at Lewisburg, where concentrations were the lowest in spring. Nitrite plus nitrate concentrations at the sampled tributary sites also were highest during winter and lowest during summer, except for the Swatara Creek at Hershey. Concentrations at Hershey were lowest during winter and highest during summer. Seasonal concentrations differed significantly from site to site even though seasonal water discharges, in cubic feet per second per square mile, were often similar.

Changes in base-flow concentrations in the Conestoga River at Conestoga occurred after May 1988 when a sewage-treatment plant in Lancaster, Pa. was upgraded to provide for reductions in ammonia and phosphorus content to the effluent. Most notably, ammonia concentrations in base flow decreased about 79 percent, from an average of 0.29 mg/l to 0.06 mg/l, after the treatment plant was upgraded. Total phosphorus concentrations in base flow decreased by 40 percent, from an average of 0.37 mg/l to 0.22 mg/l.

Loads calculated for Danville indicate that 51 percent of the total nitrogen, 59 percent of the nitrite plus nitrate, 42 percent of the organic nitrogen, 46 percent of the dissolved phosphorus, 34 percent of the total phosphorus, and 11 percent of the suspended sediment were transported during base flow. Monthly base-flow loads of all constituents were much higher during winter than during summer.

Loads calculated for Sherman Creek indicate 35 percent of the total nitrogen, 42 percent of the nitrite plus nitrate nitrogen, 23 percent of the organic nitrogen, 30 percent of the dissolved phosphorus, 17 percent of the total phosphorus and 3 percent of the suspended sediment were carried by base flows. For the two periods, before and after May 1988, the load of total ammonia transported by base flow in the Conestoga River at Conestoga was 41 and 21 percent, respectively, of the total-ammonia load transported by all flows. The load of total phosphorus transported by base flow in the same two periods was 34 and 20 percent, respectively, of the annual load.

Nutrient and suspended-sediment concentrations in samples collected during stormflows exhibited the usual discharge related variations as well as seasonal variability. Seasonal storm hydrographs for Danville show that winter storms produce the highest flows, followed by spring and fall. Summer storms cause usually the smallest seasonal rise in the Susquehanna River at Danville; however, the nitrite plus nitrate concentrations, at 0.82 to 1.03 mg/l, were as high as the winter-storm concentrations, at 0.88 to 1.12 mg/l, and increased with increasing flows. In contrast, nitrite plus nitrate concentrations for winter, spring, and fall storms generally decreased as water discharge increased, with minimum concentrations occurring after peak flows. The concentrations then increased until base flows were attained.

Seasonal patterns in storm-water discharges and nitrite plus nitrate concentrations for Shermans Creek at Shermans Dale differ from those for Danville. Spring storms had the highest water discharges, summer storms produced the next-highest seasonal flows. Winter and fall storms had the lowest flows. However, winter storms produced the highest concentrations of nitrite plus nitrate (1.6 to 2.1 mg/l), followed by the fall and summer storms (1.4 to 1.7 mg/l and 0.75 to 1.9 mg/l), respectively. The concentrations increased with increasing water discharge and continued increasing for several hours after peak flow; they then remained relatively constant during the remainder of the recession hydrograph in all seasons, which contrasts with the response at Danville.

Water discharge and nitrite plus nitrate concentrations for the Conestoga River show that storms sampled during winter and fall tended to produce smaller loads than those sampled during spring and summer. However, the highest concentrations of nitrite plus nitrate occurred during winter storms (4.0 to 8.8 mg/l) and the lowest concentrations (2.2 to 5.8 mg/l) occurred during summer storms, which had the highest flows. Nitrite plus nitrate concentrations during storms decreased from the start of the storm runoff to an average of 7 hours after the time of peak flow; they then increased over the next 41 hours to approximately values observed 24 hours before peak flow. Ammonia concentrations were lower in the storm-water samples after the new sewage-treatment plant went on line, with concentrations at the time of peak flow decreasing from 0.6 to 0.08 mg/l during winter storms, from 0.32 to 0.26 mg/l for spring storms, from 0.34 to 0.10 mg/l for summer storms, and from 0.22 to 0.12 mg/l for fall storms.

The seasonal variations in nutrient and suspended-sediment concentrations observed during both base flow and stormflow emphasize the need for periodic collection of samples throughout the year. The estimates of nutrient loads transported during base flow also shows the importance of sampling during both base flows and stormflows.

Annual and seasonal loads were calculated using the minimum variance unbiased-estimator technique. The annual loads of the nitrogen and phosphorus species, and suspended sediment generally were highest during the years when the discharge was highest. There was a significant decrease in the total ammonia loads in the Conestoga River in 1988 (29 percent) and 1989 (53 percent) even though the annual discharge increased during both years. There was similar decrease in ammonia load in the Codorus Creek at Pleasureville in 1989. These decreases can be attributed to upgrading of municipal sewage treatment plants. Total phosphorus loads in the Conestoga remained the same in 1988 and 1989 even though the annual discharge increased from 111 percent of the long-term average discharge to 135 percent. This absence of corresponding increase of phosphorus load with increase in discharge can be attributed to phosphorus removal at the upgraded sewage treatment plant.

In the 5 years of data collection, calendar years 1986 and 1989 produced the highest streamflows which coincided with the highest nutrient and suspended-sediment loads in a single season for all collection sites. This occurred during the winter of 1986 and the spring of 1989. This is probably due to the fact that the annual basin streamflow, as measured at Conowingo, was higher, for each of these 2 years than the long-term average streamflow for the basin. When annual mean streamflows were below the long-term average, as in 1985, 1987, and 1988, the seasons with the highest water discharge did not necessarily produce the corresponding highest seasonal loadings of nutrients and suspended-sediment loading. Additionally, water discharge for calendar year 1985 ran contrary to the long-term seasonal trend in that a majority of sampling sites recorded their highest seasonal discharge during the fall, rather than winter or spring.

The five years of load, or yield, values for TN, TP, and suspended sediment show ranges that allow the sampling sites to be categorized into four groups. The Renovo and Dauphin sampling sites represent areas that are completely forested and, as a group, show the lowest TN, TP, and suspended-sediment yield ranges (2.0 to 3.8 lbs/ac/yr TN, .03 to .22 lbs/ac/yr TP, and

30 to 250 lbs/ac/yr suspended sediment). In the next group of sampling sites, Lewisburg, Newport, Shermans Dale, and Penbrook are on tributaries and Danville, Harrisburg, and Marietta are on the main stem. In this group, nitrogen yields are 3.9 to 9.4 lbs/ac/yr, phosphorus yields are 0.17 to 0.60 lbs/ac/yr, and suspended-sediment yields are 100 to 500 lbs/ac/yr. These two groups of monitor sites represent areas that produce less than 1 ton of animal manure per acre per year and, except for Penbrook, have not undergone much areal development. The third group of sampling sites--Hershey, Manchester, York, and Pleasureville--have nutrient yields in the range of 8 to 21 lbs TN, 0.34 to 1.5 lbs TP, and 200 to 1,460 lbs/ac/yr suspended sediment, which are higher yields than those of the previous two groups. Their drainages produce from 1 to nearly 2 tons of animal manure per acre per year and are undergoing areal development. The Conestoga drainage, which produces more than 5 tons of animal manure per acre per year, produced nutrient yields of 26 to 45 lbs/ac/yr TN, 1.53 to 2.89 lbs/ac/yr TP, and 480 to 1,670 lbs/ac/yr suspended sediment.

The annual nutrient and suspended-sediment loads and yields show year-to-year variabilities for each site that are strongly related to water discharge. Nutrient and suspended-sediment loads and yields were adjusted to long-term averages in order to minimize bias caused by flows in the sampling period and for making comparisons between sites. Comparability was accomplished by relating the yearly loads (or yields) and the annual mean water discharges in the sampling period to the long-term average water discharge. This was accomplished by plotting water discharges as a ratio of the annual mean water discharges and the long-term average water discharges against the annual loads (or yields).

The resulting plot or regression line should be thought of as the 1985-89 "baseline". This baseline can be used to estimate an average load or yield for the base-sampling period that has been adjusted to the period of long-term water discharge. This estimate is obtained from the relation as the yield value for a water-discharge ratio (R) of 1 and is termed the "baseline yield".

Nutrient baselines for the sampled sites were superimposed on one graph for comparative purposes. These baselines fall into four broad groups that were related to land use, manure production, and average yields. These groupings indicate that loss of nutrients and suspended sediment, as loading of streamflow, increases as forested areas are replaced by agriculture and urbanization. However, land need not be forested to have a low nutrient and suspended-sediment loss; it can be idle land that was formerly farmed, a meadow, or wetland. This is illustrated by Paxton Creek whose average annual total nitrogen yield of 8.12 lbs/ac places it in the group with 60-80 percent forest and 5-10 percent urban areas, when actually its land use is considered 41 percent urban and 40 percent idle land that is being encroached upon by development. The urban area is sewered and the treated sewage is discharged below the sampling site. The average annual suspended-sediment yield of 2,273 lbs/ac is typical of the group of basins with 15 percent forest and 20-25 percent urban lands. This high sediment yield was due to active construction activities noted above the sampling site.

The average annual suspended-sediment yield of 1,128 lbs/ac at Conestoga places it in the group of 35-40 percent forest and 10-20 percent urban lands, but actual land use is 15 percent forest and 20-25 percent urban land. The suspended-sediment yield was about half of that at Penbrook, but total nitrogen and total phosphorus yields were higher by 4.1 and 3.4 times, respectively. This is possibly due to the higher rates of manure application in the Conestoga River basin. Manure production in this basin was the highest at 5.24 tons/ac/yr of all the monitored basins; this rate is 3,700 times the applied 0.0014 tons/ac/yr in the Paxton Creek basin.

The Conestoga River at Conestoga was the only sampling site to show any definable trend in nutrient loading. The 1989 load of TP was indicative of a significant reduction from the previous 4-year baseline loading rate, and appeared to have resulted primarily from an upgrading of the Lancaster Regional Sewage Treatment Plant.

A comparison of the 1985-89 average sediment yield with those of 1962-67, as reported by Williams and Reed (1972), showed little variation in yield over the 27-year period at Danville, Lewisburg, Newport, and Harrisburg. Population data of the U.S. Department of Commerce show that representative counties in the basin, such as Columbia, Lackawanna, and Luzerne had a nominal loss of 1,818 inhabitants from 1960 to 1980, and a decrease of 114,040 farmland acres from 1964 to 1987. However, an increase in nitrate concentrations is noted when comparing 1945-51 and 1985-89 nitrate concentrations collected at Danville (0.52 vs 0.81 mg/l), at Lewisburg (0.31 vs .067 mg/l), and at Newport (0.69 vs 1.33 mg/l). This increase is probably due, in part, to sewering of much of the urban areas, with much less reliance on septic systems. This has brought more sewage, albeit treated, directly to the stream than was possible from faulty septic systems.

In contrast, sediment yields increased at the Shermans Dale, Hershey, Manchester, and Conestoga sampling sites because of development--at the expense of agricultural land. Among the five counties of Lancaster, York, Adams, Cumberland, and Dauphin, there was a loss of 70,430 harvested acres (110 square miles) from 1964 to 1987. This is an 8 percent-decrease in harvested acreage. At about the same time, the 1960-80 human population in these counties increased by more than 240,000.

The nutrient and suspended-sediment loads measured at Conowingo do not reflect total basin loads transported to the reservoirs by the Susquehanna River and its tributaries. Total basin loads were estimated for each of the 5 years, 1985-89, by adding the loads transported by the Susquehanna River at Harrisburg to those of the sampled tributaries below Harrisburg, and including estimates for the unmeasured tributaries. The loads at Conowingo were calculated by using data collected during the same 5 years. The average annual baseline total nitrogen, total phosphorus, and suspended-sediment loads were computed for the basin and for Conowingo. Total nitrogen and total phosphorus loads for the basin were 150 x 10^6 and 8.70 x 10^6 pounds, respectively. The total nitrogen and total phosphorus loads for Conowingo were 147 x 10^6 and 5.13 x 10^6 pounds, respectively. The difference in the total nutrient loads is most likely due to reservoir entrapment. Suspended-sediment loads for the basin and Conowingo were 6,180 x 10^6 pounds and 1,780 x 10^6 pounds, respectively. In order to estimate the contribution from Pennsylvania to the basin load, the loads generated in New York were deducted from the total. Based on limited data, total nitrogen, total phosphorus, and suspended sediment from New York were estimated as 26 x 10^6 pounds, 1.60 x 10^6 pounds and 1,280 x 10^6 pounds, respectively. The average annual basin load of 6,180 x 10^6 pounds of sediment compares favorably with the estimate of 6,000 x 10^6 pounds reported by Williams and Reed (1972). Based on the average annual load computed for Conowingo, 4,400 x 10^6 pounds, or 71 percent of the sediment, are entrapped annually. Lang (1982) reported that 4,600 x 10^6 pounds of suspended sediment were measured at Harrisburg and 2,450 x 10^6 pounds were measured at Conowingo. These figures indicate that

45 percent of the suspended sediment was being trapped in the reservoir during his survey. However, his percentage of suspended sediment that was entrapped would be greater if he had taken the suspended-sediment loads from the areas below Harrisburg into account. Williams and Reed (1982) reported an average annual entrapment of 2,400 x 10^6 pounds of sediment. Total basin loads, rather than the Conowingo loads, might provide the better values for evaluation of Best Management Practices.

The sampling site on the Susquehanna River at Marietta is the southernmost station upstream of the reservoirs. It is believed to be best-suited main stem station for estimating basin loads, because of reduced errors in collection and load estimation. Long-term average annual loads of total nitrogen, total phosphorus, and suspended sediment, computed from data collected at this station during 1987-89, are 153 x 10^6 pounds, 8.74 x 10^6 pounds and 6,820 x 10^6 pounds, respectively.

This study has reinforced earlier conclusions that the highest nutrient yields come from the lower Susquehanna River basin. The lower basin, which constitutes nearly 19 percent of the watershed, contributes 28 percent of the average TP load, 38 percent of the average TN load, and 45 percent of the average suspended-sediment load. It is possible that a stricter enforcement of erosion-control measures at construction sites, particularly those sites that are on highly fertile agricultural land, could, along with conservation measures being implemented in agriculture, result in a substantial reduction in the excess nutrient load.

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INTRODUCTION

The quality of the nutrient and sediment data collected during the study was evaluated by several methods. Both the Pa. DER Bureau of Laboratories in Harrisburg and the U.S. Geological Survey's Central Laboratory in Arvada, Colorado, participate in the Round Robin Water-Quality-Assurance Program and are accredited by the U.S. Environmental Protection Agency. Data from the Round Robin program are available from other sources and are not repeated here. Blank and spiked samples were sent to the Pa. DER Laboratory. Duplicate (two samples from the same volume of water) and replicate (samples from the same site, but collected by different methods) samples were collected at several locations. Duplicate intra-laboratory samples were all analyzed by the Pa. DER Laboratory; duplicate inter-laboratory samples were sent to the Pa. DER and the USGS Central Laboratory. All replicate samples were analyzed by the Pa. DER Laboratory. All duplicate and replicate suspended-sediment samples were analyzed by the USGS Sediment Laboratory in Harrisburg.

BLANK SAMPLES

Analytical results of blank-sample analyses are listed in table A1. Both dissolved and total nitrite plus nitrate concentrations were well within acceptable limits. The mean concentration of 22 blank samples sent for dissolved nitrite plus nitrate analysis was 0.022 mg/l, and the mean concentration of 33 blanks sent for total nitrite plus nitrate analysis was 0.025 mg/l. Results of the analyses of blank samples for Kjeldahl nitrogen were within acceptable limits for the Kjeldahl procedure, the detection limit is 0.20 mg/l. The mean concentration of dissolved Kjeldahl nitrogen in 21 samples was 0.31 mg/l. Concentrations ranged from 0.10 to 0.60 mg/l; 5 were reported at or below the detection limit. The mean concentration of total

TABLE A1.--Blank-sample analyses by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	Range	Mean	Standard Deviation
		mg/l		
		Dissolved		
Ammonia	21	0.005-0.11	.049	0.024
Kjeldahl nitrogen	21	0.10 - .60	.31	.16
Nitrate	22	.005- .08	.022	.016
Nitrite	21	.001- .014	.005	.004
Phosphorus	20	.01 - .05	.022	.012
		Total		
Ammonia	32	.01 - .33	.063	.067
Kjeldahl nitrogen	32	.10 -1.00	.36	.24
Nitrate	33	.01 - .16	.025	.026
Nitrite	30	.001- .018	.007	.004
Phosphorus	32	.01 - .11	.029	.022

Kjeldahl nitrogen in 32 samples was 0.36 mg/l. Concentrations ranged from 0.10 to 1.00 mg/l, of which 9 were reported at or below the detection limit. The mean concentrations of dissolved and total ammonia were 0.049 and 0.063 mg/l, respectively, and the mean concentrations of dissolved and total phosphorus were 0.022 and 0.029 mg/l, respectively. Sixteen of 32 blank samples analyzed for total phosphorus were reported at or below the detection limits of 0.02 mg/l.

SPIKED SAMPLES

Analyses of spiked samples sent to the Pa. DER Laboratory were also within acceptable levels. The mean concentration of total nitrite plus nitrate in 14 samples sent to the lab was 2.84 mg/l; the range was 0.80 to 8.00 mg/l; and the mean concentration reported by the lab was 2.55 mg/l, for values in the range of 0.82 to 8.58 mg/l. The mean concentrations of dissolved and total phosphorus in samples sent to the laboratory were 1.55 mg/l (n = 13) and 1.51 mg/l (n = 15), respectively; the corresponding mean concentrations reported by the lab were 1.77 and 1.72 mg/l. Mean concentrations reported by the lab for Kjeldahl nitrogen were 10 to 15 percent higher than standard determinations for the spiked samples. A summary of the statistical results from the spiked samples is presented on table A2.

TABLE A-2. Results of analyses of U.S. EPA spiked samples as analyzed by the Pa. DER, Bureau of Laboratories, Harrisburg, Pa.

		Spiked Concentrations			Laboratory Concentrations			Regression			
								*Equation		Correlation Coefficient	
Constituent	Number of analysis	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	A	B	R^2	P
		mg/l									
					Dissolved						
Ammonia	13	0.76- 7.60	3.51	2.06	0.43- 7.35	2.81	1.97	0.81	1.24	0.59	0.002
Kjeldahl nitrogen	13	4.88-15.54	7.70	3.55	1.30-17.20	8.48	4.40	.72	1.58	.80	<.001
Nitrite plus nitrate	12	.80- 8.00	3.04	2.00	.82- 8.58	2.74	4.58	.81	.83	.74	<.001
Phosphorus	13	.71- 3.51	1.55	.77	.72- 3.74	1.77	.82	.83	.091	.80	<.001
					Total						
Ammonia	15	.76- 7.60	3.34	1.98	.44- 7.35	2.67	1.91	.81	1.18	.61	.001
Kjeldahl nitrogen	15	4.88-15.54	7.42	3.38	1.30-17.20	8.76	4.41	.72	1.10	.89	<.001
Nitrite plus nitrate	14	.80- 8.00	2.84	1.91	.82- 8.58	2.55	2.03	.82	.74	.76	<.001
Phosphorus	15	.71- 3.51	1.51	.77	.72- 3.74	1.72	.82	.79	.14	.89	<.001

* Equation states: Spiked value = A (Lab value) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation

P Probability that the slope of the regression line is not equal to zero

INTER-LABORATORY DUPLICATES

Inter-laboratory duplicate samples were collected for analysis by the Pa. DER Laboratory and the USGS Laboratory in Arvada. Duplicate samples were collected by the USGS when sampling at Danville, Lewisburg, and Harrisburg. Duplicate samples also were collected at Conowingo for analysis at both laboratories. A statistical summary of these samples is presented on tables A3 through A6. A total of about 56 inter-laboratory duplicates were analyzed; 23 were from Conowingo.

Results from all four sites were encouraging. Mean concentrations of dissolved nitrite plus nitrate from the Pa. DER and the USGS laboratories were within 5 percent at all four sites and were the same at Conowingo, 1.24 and 1.23 mg/l, respectively. Inter-laboratory results for total Kjeldahl nitrogen were within 10 percent (0.06 mg/l) for Danville, Lewisburg, and Harrisburg. Results reported by Pa. DER were lower than those reported by USGS for Danville but higher for Lewisburg and Harrisburg. The mean concentrations reported for the inter-laboratory duplicates collected at Conowingo varied by 40 percent; the mean concentration of the analyses reported by the USGS Laboratory was 0.66 mg/l and that reported by the Pa. DER Laboratory was 0.47 mg/l. The mean concentration of total nitrogen in the samples from Conowingo analyzed by Pa. DER was 1.71 mg/l and the mean concentration of the samples analyzed by USGS was 1.89 mg/l, a difference of 10 percent. Mean concentrations of total nitrogen reported by the USGS Laboratory for the samples collected at Danville, Lewisburg, and Harrisburg were 1.54, 1.03, and 1.82 mg/l, and the mean concentrations reported by the Pa. DER Laboratory were 1.54, 1.11, and 1.95 mg/l, respectively, for the three sites.

Inter-laboratory analyses of water samples for total phosphorus showed no distinct pattern. The mean concentrations reported by the two laboratories

TABLE A3.--Results of analyses of inter-laboratory duplicate samples collected from the Susquehanna River at Danville, Pa., and analyzed by the U.S. Geological Survey Central Laboratory, Arvada, Colo., and the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	USGS Laboratory			Pa. DER Laboratory			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
					Dissolved						
Ammonia	12	0.01-0.13	0.049	0.042	0.005-0 14	0.038	0.042	0.87	0.016	0.77	<0.001
Nitrite plus nitrate	10	.33-1.10	.77	.22	.32 -1.24	.81	.26	.86	.072	.96	<.001
Ortho phosphorus	12	.005- .04	.014	.010	.002- .021	.008	.008	**	**	**	**
Phosphorus	12	.01- .080	.025	.020	.02 - .05	.036	.012	**	**	**	**
					Total						
Ammonia	11	.01- .10	.045	.034	.010- .15	.043	.044	.43	.027	.31	.07
Kjeldahl nitrogen	12	.20-1.40	.77	.40	.22 -1.55	.73	.45	.63	.31	.51	.01
Phosphorus	12	.01- .32	.11	.10	.05 - .24	.11	.064	1.32	-.038	.65	.002

* Equation states: USGS value = A (Pa. DER value) + B

** Insufficient data to compute a regression equation

Correlation Coefficient: R^2 Percent of the variation explained by the equation

P Probability that the slope of the regression line is not equal to zero

TABLE A4.--Results of analyses of inter-laboratory duplicate samples collected from the West Branch Susquehanna River at Lewisburg, Pa., and analyzed by the U.S. Geological Survey Central Laboratory, Arvada, Colo., and the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	USGS Laboratory			Pa. DER Laboratory			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
					Dissolved						
Ammonia	9	0.01 -0.08	0.039	0.023	0.01 - .09	0.025	0.025	**	**	**	**
Nitrite plus nitrate	9	.51 - .95	.69	.15	.58 - .99	.73	.16	.96	.014	.97	<.001
Ortho phosphorus	9	.005- .03	.014	.009	.001- .022	.006	.007	.74	.001	.28	.14
Phosphorus	9	.005- .06	.020	.019	.02 - .06	.031	.014	**	**	**	**
					Total						
Ammonia	9	.01 - .07	.042	.024	.010- .09	.032	.025	**	**	**	**
Kjeldahl nitrogen	8	.20 - .70	.34	.20	.10 -1.00	.38	.29	.65	.088	.87	.001
Phosphorus	9	.03 - .16	.058	.039	.01 - .11	.034	.033	.80	-.013	.87	<.001

* Equation states: USGS value = A (Pa. DER value) + B

** Insufficient data to compute a regression equation

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A-5. Results of analyses of inter-laboratory duplicate samples collected from the Susquehanna River at Harrisburg, Pa., and analyzed by the U.S. Geological Survey Central Laboratory, Arvada, Colo., and the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

		USGS Laboratory			Pa. DER Laboratory			Regression			
								*Equation		Correlation Coefficient	
Constituent	Number of analysis	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	A	B	R^2	P
		mg/l									
					Dissolved						
Ammonia	12	0.01 -0.08	0.037	0.029	0.010- .085	0.035	0.028	0.65	0.014	0.39	0.029
Nitrite plus nitrate	11	.86 -1.70	1.34	.26	.90 -1.90	1.41	.31	.84	.16	.96	<.001
Ortho phosphorus	12	.005- .03	.013	.007	.001- .025	.008	.007	**	**	**	**
Phosphorus	11	.01 - .03	.020	.006	.02 - .05	.036	.012	**	**	**	**
					Total						
Ammonia	12	.01 - .10	.039	.030	.010- .095	.037	.029	.78	.011	.61	.003
Kjeldahl nitrogen	12	.20 -1.10	.48	.22	.21 -2.20	.54	.55	**	**	**	**
Phosphorus	12	.01 - .16	.049	.045	.03 - .15	.076	.034	.94	-.023	.72	.009

* Equation states: USGS value = A (Pa. DER value) + B

** Insufficient data to compute a regression equation

Correlation Coefficient: R^2 Percent of the variation explained by the equation

P Probability that the slope of the regression line is not equal to zero

TABLE A6.--Results of analyses of inter-laboratory duplicate samples collected from the Susquehanna River at Conowingo, Md., and analyzed by the U.S. Geological Survey Central Laboratory, Arvada, Colo., and the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	USGS Laboratory			Pa. DER Laboratory			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
					Dissolved						
Ammonia	24	0.01 -0.21	0.082	0.035	0.02 - .19	0.069	0.039	0.43	0.053	0.22	0.021
Kjeldahl nitrogen	23	.10 -1.20	.42	.21	.10 - .80	.37	.17	**	**	**	**
Nitrite plus nitrate	24	.77 -2.00	1.23	.34	.80 -1.98	1.24	.30	1.10	-.13	.95	<.001
Ortho phosphorus	23	.001- .02	.008	.004	.001- .04	.006	.008	.15	.007	.078	.197
Phosphorus	23	.005- .04	.014	.008	.012- .04	.029	.007	**	**	**	**
					Total						
Kjeldahl nitrogen	24	.20 -1.90	.66	.40	.10 - .90	.47	.24	.51	.42	.089	.16
Organic carbon	22	2.6 -8.6	4.05	1.66	2.3 -6.4	3.52	1.22	.90	.87	.44	.001
Phosphorus	24	.04 - .15	.076	.034	.01 - .13	.052	.028	.25	.033	.92	.149

* Equation states: USGS value = A (Pa. DER value) + B

** Insufficient data to compute a regression equation

Correlation Coefficient: R^2 Percent of the variation explained by the equation

P Probability that the slope of the regression line is not equal to zero

for the samples collected at Danville were the same (0.11 mg/l). Results reported by the Pa. DER Laboratory were lower than those reported by the USGS for the samples collected at Lewisburg (0.034 vs. 0.058 mg/l), and at Conowingo (0.052 vs. 0.076 mg/l); but were higher for the samples collected at Harrisburg (0.076 vs. 0.049 mg/l). The mean concentrations of dissolved phosphorus reported by the Pa. DER Laboratory were higher for all sites. The largest percentage difference in analytical results for dissolved phosphorus was for the samples collected at Conowingo, for which the mean concentration reported by the Pa. DER Laboratory was 0.029 mg/l, as compared to a mean concentration of 0.014 mg/l reported by the USGS Laboratory. Detection limits of the procedures used by the Pa. DER Laboratory was 0.02 mg/l for both dissolved and total phosphorus and the detection limits of the procedures used by the USGS Laboratory was 0.001 mg/l.

INTRA-LABORATORY DUPLICATES

Duplicate intra-laboratory samples were collected at Danville, Lewisburg, Newport, Harrisburg, Manchester, Marietta, and Conestoga. Since these samples are assigned to one of two sets at random, the difference in mean concentrations of the two groups has no meaning. A total of 66 samples were collected; a statistical summary of these samples is presented on Tables A-7 through A-13. The highest R^2 values were calculated for dissolved and total nitrite plus nitrate; they ranged from 0.97 mg/l at Conestoga to 0.99 mg/l at Danville, none of reported concentrations of nitrite plus nitrate were near the detection limits. The R^2 values for total Kjeldahl nitrogen ranged from 0.74 to 0.97 mg/l, and the values for total phosphorus ranged from 0.76 to 0.99 mg/l.

TABLE A7.--Results of analyses of intra-laboratory duplicate samples collected from the Susquehanna River at Danville, Pa., and analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

		Dependent Variables			Independent Variables			Regression			
								*Equation		Correlation Coefficient	
Constituent	Number of analysis	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	A	B	R^2	P
					mg/l						
					Dissolved						
Ammonia	7	0.01 -0.08	0.041	0.029	0.01 - .10	0.046	0.034	0.83	0.003	0.96	<0.001
Kjeldahl nitrogen	7	.10 - .67	.25	.20	.10 - .67	.24	.20	1.00	.008	.99	<.001
Nitrite plus nitrate	7	.26 -1.08	.78	.26	.28 -1.10	.79	.26	1.01	-.013	.99	<.001
Ortho phosphorus	7	.002- .015	.005	.005	.001- .07	.015	.025	**	**	**	**
Phosphorus	7	.02 - .05	.029	.012	.02 - .05	.033	.014	.81	.002	.85	.003
					Total						
Ammonia	7	.04 - .24	.084	.07	.05 - .24	.086	.069	.80	.006	.95	<.001
Kjeldahl nitrogen	7	.10 -1.66	.53	.53	.10 -1.44	.49	.45	1.15	-.025	.96	<.001
Nitrite plus nitrate	7	.26 -1.10	.79	.27	.28 -1.10	.79	.26	1.01	-.01	.99	<.001
Organic carbon	7	2.4 -4.4	3.24	.85	2.2 -3.7	3.06	.57	.63	1.00	.88	.002
Phosphorus	7	.04 - .24	.084	.070	.05 - .24	.086	.069	1.02	-.003	.99	<.001

* Equation states: Dependent value = A (Independent value) + B
** Insufficient data to compute a regression equation

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A8.--Results of analyses of intra-laboratory duplicate samples collected from the West Branch Susquehanna River at Lewisburg, Pa., and analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

		Dependent Variables			Independent Variables			Regression			
Constituent	Number of analysis	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
					Dissolved						
Ammonia	7	0.01 -0.06	0.026	0.018	0.01 - .04	0.027	0.014	0.98	-0.001	0.55	0.056
Kjeldahl nitrogen	7	.10 - .50	.18	.15	.10 - .59	.20	.18	.82	.009	.94	<.001
Nitrite plus nitrate	7	.66 -1.01	.75	.13	.66 - .97	.75	.11	1.11	-.073	.99	<.001
Ortho phosphorus	7	.001- .018	.007	.006	.001- .018	.007	.006	1.01	.0002	.95	<.001
Phosphorus	7	.03 - .06	.037	.012	.02 - .06	.030	.015	.79	.014	.92	.014
					Total						
Ammonia	7	.01 - .06	.026	.018	.01 - .05	.026	.015	1.15	-.004	.91	.001
Kjeldahl nitrogen	7	.10 - .92	.25	.31	.10 -1.11	.29	.37	.82	.016	.97	<.001
Nitrite plus nitrate	7	.66 -1.01	.75	.13	.66 - .97	.75	.11	1.11	-.07	.99	<.001
Organic carbon	7	1.1 -1.9	1.47	.26	1.1 -1.7	1.42	.21	1.15	-.17	.88	.002
Phosphorus	7	.03 - .16	.063	.044	.03 - .15	.056	.043	1.02	.006	.97	<.001

* Equation states: Dependent value = A (Independent value) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A9.--Results of analyses of intra-laboratory duplicate samples collected from the Juniata River at Newport, Pa., and analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

		Dependent Variables			Independent Variables			Regression			
								*Equation		Correlation Coefficient	
Constituent	Number of analysis	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	A	B	R^2	P
		mg/l									
					Dissolved						
Ammonia	6	0.01 -0.06	0.030	0.018	0.02 - .05	0.028	0.013	1.24	-0.005	0.86	0.008
Kjeldahl nitrogen	6	.10 - .37	.26	.090	.10 - .26	.22	.12	.62	.12	.68	.042
Nitrite plus nitrate	6	1.32 -1.67	1.49	.13	1.32 -1.67	1.49	.13	.97	.050	.99	<.001
Ortho phosphorus	6	.001- .014	.006	.004	.001- .012	.005	.004	.83	.002	.58	.079
Phosphorus	6	.03 - .04	.035	.006	.03 - .04	.038	.004	**	**	**	**
					Total						
Ammonia	6	.02 - .08	.035	.024	.02 - .05	.033	.012	1.50	-.015	.60	.070
Kjeldahl nitrogen	6	.27 - .60	.38	.11	.25 - .78	.39	.20	.49	.19	.74	.028
Nitrite plus nitrate	6	1.32 -1.67	1.50	.13	1.32 -1.67	1.49	.13	.94	.089	.98	<.001
Organic carbon	6	2.2 -4.0	2.97	.69	2.3 -4.0	3.00	.69	1.00	-.02	.98	<.001
Phosphorus	6	.04 - .14	.072	.040	.04 - .11	.075	.040	.98	-.002	.98	<.001

* Equation states: Dependent value = A (Independent value) + B

** Insufficient data to compute a regression equation

Correlation Coefficient: R^2 Percent of the variation explained by the equation

P Probability that the slope of the regression line is not equal to zero

TABLE A10.--Results of analyses of intra-laboratory duplicate samples collected from the Susquehanna River at Harrisburg, Pa., and analized by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

		Dependent Variables			Independent Variables			Regression			
								*Equation		Correlation Coefficient	
Constituent	Number of analysis	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	A	B	R^2	P
		mg/l									
					Dissolved						
Ammonia	20	0.01 -0.08	0.025	0.020	0.01 - .09	0.024	0.021	0.94	0.002	0.94	<0.001
Kjdelhal nitrogen	20	.10 -.57	.25	.14	.10 - .50	.25	.13	.94	.018	.78	<.001
Nitrite plus nitrate	20	.55 -1.90	1.20	.32	.55 -1.90	1.20	.32	1.00	.000	.99	.000
Ortho phosphorus	20	.001- .008	.003	.002	.001- .008	.003	.002	.78	.001	.55	<.001
Phosphorus	20	.02 - .15	.038	.028	.01 - .05	.035	.012	1.38	-.010	.31	.010
					Total						
Ammonia	20	.01 - .08	.026	.022	.01 - .09	.026	.022	.95	.001	.92	<.001
Kjeldahl nitrogen	20	.10 - .99	.44	.27	.10 - .91	.45	.27	.95	.036	.87	<.001
Nitrite plus nitrate	18	.55 -1.92	1.20	.32	.55 -1.92	1.20	.32	1.00	.003	.99	<.001
Organic carbon	20	1.6 -5.5	2.71	.79	1.8 -5.6	2.74	.79	1.00	.027	.94	<.001
Phosphorus	20	.03 - .20	.067	.044	.03 - .21	.067	.046	.92	.005	.92	<.001
Suspended sediment	31	15-689	137	199	14-682	135	195	1.02	-.50	.99	<.001

* Equation states: Dependent value = A (Independent value) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A11.--Results of analyses of intra-laboratory duplicate samples collected from the West Conewago Creek near Manchester, Pa., and analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	Dependent Variables			Independent Variables			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
		Dissolved									
Ammonia	4	0.02 -0.03	0.024	0.005	0.02 - .04	0.029	0.008	0.43	0.011	0.58	0.236
Kjeldahl nitrogen	4	.10 - .40	.32	.14	.10 - .44	.29	.14	.86	.066	.73	.147
Nitrite plus nitrate	4	1.68 -3.83	2.35	1.02	1.60 -3.96	2.37	1.10	.93	.15	.99	.001
Ortho phosphorus	4	.006- .09	.048	.036	.007- .09	.047	.035	1.02	.000	.99	.003
Phosphorus	4	.03 - .12	.082	.041	.03 - .12	.082	.041	1.00	.000	.99	.000
		Total									
Ammonia	4	.02 - .03	.024	.005	.02 - .04	.029	.008	.43	.011	.58	.236
Kjeldahl nitrogen	4	.10 -1.36	.59	.54	.23 - .98	.52	.33	1.65	-.26	.99	.004
Nitrite plus nitrate	4	1.68 -4.09	2.42	1.14	1.60 -4.09	2.40	1.16	.99	.045	.99	.001
Phosphorus	4	.04 -.20	.13	.074	.05 - .20	.13	.066	1.11	-.011	.98	.010

* Equation states: Dependent value = A (Independent value) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A12.--Results of analyses of intra-laboratory duplicate samples collected from the Susquehanna River at Marietta, Pa., and analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

		Dependent Variables			Independent Variables			Regression			
								*Equation		Correlation Coefficient	
Constituent	Number of analysis	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	A	B	R^2	P
		mg/l									
					Dissolved						
Ammonia	13	0.01 -0.10	0.040	0.032	0.01 - .11	0.040	0.031	0.99	0.001	0.89	<0.001
Kjeldahl nitrogen	13	.10 - .69	.30	.20	.10 - .55	.27	.16	1.17	-.012	.91	<.001
Nitrite plus nitrate	13	.54 -1.21	1.13	.35	.56 -1.70	1.12	.36	.98	.036	.99	<.001
Ortho phosphorus	13	.001- .011	.004	.003	.001- .009	.003	.002	.65	.002	.26	.076
Phosphorus	13	.01 - .05	.031	.011	.02 - .05	.032	.011	.75	.006	.54	.004
					Total						
Ammonia	13	.01 - .10	.045	.032	.01 - .11	.042	.032	.94	.005	.90	<.001
Kjeldahl nitrogen	13	.22 -1.35	.55	.35	.21 -1.27	.52	.33	1.01	.028	.93	<.001
Nitrite plus nitrate	13	.58 -1.72	1.14	.36	.56 -1.70	1.13	.36	.99	.026	.99	<.001
Organic carbon	13	2.2 -5.8	3.49	1.22	2.1 -6.7	3.50	1.37	.78	.77	.76	<.001
Phosphorus	13	.01 - .23	.090	.060	.03 - .23	.11	.065	.81	.003	.76	<.001

* Equation states: Dependent value = A (Independent value) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A-13. Results of analyses of intra-laboratory duplicate samples collected from the Conestoga River at Conestoga, Pa., and analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	Dependent Variables			Independent Variables			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
					Dissolved						
Ammonia	9	0.02 - 1.02	0.25	0.32	0.03 - .99	0.25	0.31	1.02	-0.009	0.99	<0.001
Kjeldahl nitrogen	9	.10 - 2.43	1.01	.74	.22 - 2.33	1.05	.71	1.00	-.04	.93	<.001
Nitrite plus nitrate	9	2.64 - 7.32	3.62	1.49	2.76 - 6.60	3.61	1.29	1.14	-.48	.97	<.001
Ortho phosphorus	9	.047- .72	.28	.18	.049- .71	.26	.19	.97	.020	.96	<.001
Phosphorus	9	.07 - .78	.32	.19	.06 - .78	.32	.19	.99	.009	.99	<.001
					Total						
Ammonia	9	.03 - 1.11	.28	.34	.03 - 1.20	.29	.37	.92	.013	.99	<.001
Kjeldahl nitrogen	9	.23 - 3.98	2.17	1.36	.31 - 4.48	2.12	1.38	.85	.36	.75	.355
Nitrite plus nitrate	9	2.64 - 8.16	3.78	1.73	2.76 - 7.08	3.74	1.40	1.23	-.81	.98	<.001
Organic carbon	9	2.6 -14.0	8.64	3.52	2.6 -13.7	8.58	3.44	1.02	-.13	.99	<.001
Phosphorus	9	.17 - 1.54	.77	.48	.17 - 1.44	.74	.48	.96	.059	.91	<.001

* Equation states: Dependent value = A (Independent value) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation

P Probability that the slope of the regression line is not equal to zero

The statistical summary of duplicate intra-laboratory samples for suspended-sediment analysis are reported with the intra-laboratory samples for Harrisburg. The R^2 value was 0.99 for the 31 samples. Reported concentrations ranged from 14 to 689 mg/l.

INTER-LABORATORY REPLICATES

Inter-laboratory replicate samples were collected at three sites. Replicate samples were collected at Pleasureville and Conestoga to insure that the automatic samplers were collecting representative samples. Replicates also were collected at Harrisburg. During the course of the study the number of cross-sections sampled at Harrisburg was changed from 6 to 15 so that a more representative sample would be obtained. Statistical summaries of the replicate samples are listed on tables A14, A15, and A16.

Thirty replicate samples were collected at Pleasureville. Suspended-sediment concentrations of the samples collected using depth-integrating equipment ranged from 12 to 2,170 mg/l, and the mean was 564 mg/l; concentrations of samples collected by the automatic sampler ranged from 14 to 2,330 mg/l, and the mean was 648 mg/l. The indicated differences in suspended-sediment concentrations were considered significant and all suspended-sediment concentrations for samples collected by the automatic sampler were adjusted. Visual observation of the samples at the time of collection indicated that the differences in concentrations were caused mostly by higher quantities of sand in the samples collected by the automatic samplers. After mixing, sand accumulated at a higher rate on the bottom of the bottles collected by the automatic samplers. Turbidities of the samples appeared to be about the same.

TABLE A14.--Results of analyses of intra-laboratory replicate samples collected from the Codorus Creek at Pleasureville, Pa., using depth-integrating equipment and an automatic sampler; the samples were analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	Depth Integrated Samples			Automatic Samples			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
					Dissolved						
Ammonia	31	0.03 - 1.49	0.32	0.29	0.03 - 1.49	0.30	0.28	0.98	0.021	0.93	<0.001
Kjeldahl nitrogen	31	.44 - 2.92	1.00	.46	.44 - 2.42	1.00	.43	.97	.025	.83	<.001
Nitrite plus nitrate	31	1.20 - 3.60	2.54	.67	1.26 - 3.74	2.57	.73	.91	.21	.96	<.001
Ortho phosphorus	29	.014- .098	.049	.026	.012- .098	.052	.029	.65	.015	.57	<.001
Phosphorus	29	.06 - .33	.10	.051	.03 - .33	.098	.053	.96	.006	.97	<.001
					Total						
Ammonia	30	.03 - 1.87	.36	.38	.04 - 1.92	.36	.38	1.00	.004	.98	<.001
Kjeldahl nitrogen	31	1.01 -10.26	2.82	2.12	1.01 - 7.60	2.84	1.78	1.00	-.019	.71	<.001
Nitrite plus nitrate	31	1.20 - 3.74	2.59	.71	1.26 - 3.96	2.66	.77	.92	.15	.97	<.001
Organic carbon	31	4.4 -18.1	10.0	3.42	4.5 -22.4	10.4	4.14	.67	3.12	.66	<.001
Phosphorus	30	.18 - 2.09	.53	.41	.13 - 2.53	.51	.46	.83	.11	.85	<.001
Suspended sediment	32	12-2170	564	549	14-2330	648	613	.89	-10.9	.98	<.001

* Equation states: Depth Integrated value = A (Automatic value) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A15.--Results of analyses of intra-laboratory replicate samples collected from the Conestoga River at Conestoga, Pa., using depth-integrating equipment and an automatic sampler; the samples were analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	Depth Integrated Samples			Automatic Samples			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
Dissolved											
Ammonia	33	0.10 - 1.26	0.40	0.34	0.02 - 2.00	0.46	0.49	0.68	0.087	0.94	<0.001
Kjeldahl nitrogen	31	.43 - 2.70	1.17	.53	.46 - 2.98	1.16	.57	.86	.17	.86	<.001
Nitrite plus nitrate	33	1.22 - 7.92	3.88	1.73	1.30 - 8.14	3.94	1.84	.93	.21	.97	<.001
Ortho phosphorus	32	.044- .76	.21	.14	.048- .75	.22	.13	1.03	-.009	.96	<.001
Phosphorus	33	.15 - .88	.28	.14	.14 - .84	.27	.13	1.04	-.009	.94	<.001
Total											
Ammonia	33	.02 - 2.60	.57	.62	.02 - 2.90	.53	.62	.90	.094	.80	<.001
Kjeldahl nitrogen	33	1.10 -11.08	3.94	2.67	.90 -10.14	4.00	2.86	.83	.60	.79	<.001
Nitrite plus nitrate	33	1.34 - 7.92	4.08	1.73	1.34 - 8.14	4.10	1.81	.94	.21	.98	<.001
Organic carbon	33	3.3 -21.4	9.24	4.63	3.5 -30.0	9.89	5.67	.75	1.82	.85	<.001
Phosphorus	33	.29 - 4.80	1.07	.91	.28 - 3.30	1.05	.78	.79	.23	.45	<.001
Suspended sediment	33	41 -3,970	1,068	1,080	46-7,250	1,293	1,595	.65	227	.92	<.001

* Equation states: Depth Integrated value = A (Automatic value) + B

Correlaiton Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

TABLE A16.--Results of analyses of intra-laboratory replicate samples collected from the Susquehanna River at Harrisburg, Pa., at 6 and 16 points in the cross-section; the samples were analyzed by the Pa. DER Bureau of Laboratories, Harrisburg, Pa.

Constituent	Number of analysis	Sixteen Verticals			Six Verticals			Regression			
		Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	*Equation		Correlation Coefficient	
		mg/l						A	B	R^2	P
					Dissolved						
Ammonia	42	0.02 - .07	0.024	0.016	0.01 - .08	0.025	0.017	0.91	0.001	0.93	<0.001
Kjeldahl nitrogen	42	.10 - .85	.39	.19	.10 - .85	.39	.19	.85	.064	.73	<.001
Nitrite plus nitrate	42	.55 -1.46	1.02	.23	.77 -1.90	1.37	.27	.71	.045	.69	<.001
Ortho phosphorus	42	.001- .03	.003	.005	.001- .011	.003	.002	.98	.000	.24	.001
Phosphorus	41	.02 - .05	.031	.011	.02 - .06	.033	.011	.76	.006	.65	<.001
					Total						
Ammonia	42	.01 - .08	.028	.019	.01 - .08	.026	.019	.90	.004	.80	<.001
Kjeldahl nitrogen	40	.10 -1.58	.76	.37	.10 -1.45	.70	.36	.98	.080	.91	<.001
Nitrite plus nitrate	42	.55 -1.46	1.03	.23	.77 -1.92	1.38	.28	.69	.070	.70	<.001
Organic carbon	42	1.4 -4.6	2.93	.71	1.6 -4.7	2.95	.65	.88	.33	.66	<.001
Phosphorus	42	.03 - .21	.081	.043	.025- .23	.079	.042	.82	.015	.64	<.001
Suspended sediment	41	1-187	49.6	44.6	1-160	50.2	43.8	.96	2.68	.95	<.001

* Equation states: Sixteen = A (Six) + B

Correlation Coefficient: R^2 Percent of the variation explained by the equation
P Probability that the slope of the regression line is not equal to zero

Analytical results for total phosphorus and total Kjeldahl nitrogen could be affected by the same factors that affected the suspended-sediment concentrations; however, the data do not indicate any difference between the cross-sectional samples collected with depth-integrating equipment and the samples collected with the automatic sampler. Total phosphorus concentrations in samples collected with depth-integrating equipment ranged from 0.18 to 2.09 mg/l; the mean was 0.53 mg/l. The concentrations in samples collected by the automatic sampler ranged from 0.13 to 2.53 mg/l, and the mean was 0.51 mg/l. Differences in total Kjeldahl nitrogen concentrations also were not significant. Concentrations of samples collected with depth-integrating equipment ranged from 1.01 to 10.26 mg/l, and the mean was 2.82 mg/l. Concentrations of samples collected with the automatic sampler ranged from 1.01 to 7.60 mg/l, and the mean was 2.84 mg/l. The differences in mean concentrations of all other parameters was 4 percent or less. Similar small differences were observed for the range of concentrations and the standard deviations.

Replicate samples for Conestoga were collected from a bridge about 1 mile below the gage; there are no large tributaries between the two sites. The automatic sample was always collected first; about 20 minutes later the depth-integrated cross-sectional sample was collected. The suspended-sediment concentration of samples collected using depth-integrating equipment ranged from 41 to 3,970 mg/l, and the mean was 1,068 mg/l. Concentration of samples collected by the automatic sampler ranged from 46 to 7,250 mg/l, and the mean concentration was 1,293 mg/l. The differences in suspended-sediment concentrations were considered significant, so the sediment concentrations for samples collected by the automatic sampler were adjusted. As occurred at Pleasureville, the differences in concentrations appeared to be caused by excessive sand in the automatic samples.

Concentrations of total phosphorus and total Kjeldahl nitrogen did not show any difference between the cross-sectional samples collected with depth-integrating equipment and the samples collected with the automatic sampler. Total phosphorus concentrations in samples collected with depth-integrating equipment ranged from 0.29 to 4.80 mg/l, the mean was 1.07 mg/l. Concentrations in samples collected by the automatic sampler ranged from 0.28 to 3.30 mg/l, and the mean was 1.05 mg/l. Differences in total Kjeldahl nitrogen concentrations also were not significant. Concentrations in samples collected with depth-integrating equipment ranged from 1.10 to 11.08 mg/l, and the mean was 3.94 mg/l; concentrations in samples collected with the automatic sampler ranged from 0.90 to 10.14 mg/l, and the mean was 4.00 mg/l. Except for dissolved ammonia, the differences in mean concentrations of all other parameters was 4 percent or less. Similar small differences were observed for the range of concentrations and the standard deviations.

REPLICATE SAMPLES AT HARRISBURG, PENNSYLVANIA

Replicate samples were collected at Harrisburg during 1989 to insure that a representative sample was being collected. Normal samples were collected at 6 locations in the cross-section by using depth-integrating sampling equipment, and the second set of samples were collected at 16 points in the cross-section. A total of 42 replicate samples were collected during the year. A statistical summary of the data is listed in Table A-16.

Nitrite plus nitrate was the only parameter that had significantly different replicate concentrations. Concentrations of total nitrite plus nitrate in samples collected from 16 points in the cross-section ranged from 0.55 to 1.46 mg/l, and the mean was 1.03 mg/l; concentrations in samples collected from 6 points in the cross-section ranged from 0.77 to 1.92 mg/l and the mean was 1.38 mg/l. All the samples collected from 16 points in the cross-section had lower nitrite plus nitrate concentrations than their counterparts collected at 6 points. These differences were considered to be significant and the loads of nitrite plus nitrate were adjusted accordingly. Total nitrogen loads calculated for Harrisburg also were adjusted by the same amount. Concentrations of dissolved nitrite plus nitrate were similar; however, differences between the mean concentration of all other parameters were less that 5 percent.

Appendix B.--NUTRIENT SUMMARY STATISTICS

Seasonal base-flow nutrient statistics, Susquehanna River at Towanda, Pa., January 1989 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
Winter											
Maximum	6,470	8	3.300	0.480	0.250	0.080	0.080	1.100	0.070	0.050	0.010
Minimum	3,000	3	2.600	0.220	0.200	0.020	0.020	1.080	0.020	0.020 [1]	0.010
Average	5,000	6	2.960	0.320	0.210	0.050	0.050	1.080	0.040	0.030	0.010
Median	5,540	6	3.000	0.270	0.200	0.070	0.070	1.080	0.050	0.030	0.010
Analyses	3	3	3	3	3	3	3	3	3	3	1
< Limit [2]	0	0	0	0	0	0	0	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	2
Spring											
Maximum	14,900	32	4.000	0.560	0.290	0.050	0.040	0.860	0.040	0.040	0.020
Minimum	6,000	5	2.900	0.290	0.230	0.020 [1]	0.020 [1]	0.840	0.040	0.030	0.010
Average	10,400	19	3.450	0.420	0.260	0.030	0.020	0.850	0.040	0.030	0.010
Median	10,400	19	3.450	0.425	0.260	0.030	0.025	0.850	0.040	0.035	0.015
Analyses	2	2	2	2	2	2	2	2	2	2	2
< Limit [2]	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
Summer											
Maximum	4,400	17	3.800	0.450	0.340	0.030	0.030	1.190	0.100	0.100	0.040
Minimum	913	5	3.000	0.280	0.280	0.020 [1]	0.020 [1]	0.860	0.060	0.040	0.020
Average	2,400	9	3.430	0.340	0.290	0.020	0.020	0.980	0.080	0.060	0.030
Median	1,930	6	3.500	0.300	0.280	0.030	0.030	0.900	0.090	0.050	0.030
Analyses	3	3	3	3	3	3	3	3	3	3	2
< Limit [2]	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	1
Fall											
Maximum	14,600	23	6.200	0.440	0.220	0.110	0.110	1.320	0.060	0.040	0.020
Minimum	1,610	3	3.300	0.230	0.200 [1]	0.020 [1]	0.020 [1]	0.780	0.050	0.040	0.010
Average	6,900	13	4.290	0.340	0.170	0.060	0.060	0.990	0.050	0.040	0.010
Median	4,450	13	3.400	0.350	0.200 [1]	0.070	0.070	0.880	0.060	0.040	0.010
Analyses	3	2	3	3	3	3	3	3	3	3	3
< Limit [2]	0	0	0	0	1	1	1	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0

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[1] analytical detection limit

[2] number of analyses below detection limit

Seasonal stormflow nutrient statistics, Susquehanna River at Towanda, Pa., January 1989 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
					Winter						
Maximum	66,000	313	7.100	1.900	1.000	0.140	0.140	1.040	0.190	0.070	0.020
Minimum	4,560	3	3.200	0.810	0.370	0.020 1/	0.020 1/	0.740	0.050	0.040	0.010
Average	20,400	84	5.330	1.230	0.700	0.090	0.090	0.890	0.130	0.050	0.010
Median	13,800	73	5.200	1.000	0.750	0.110	0.110	0.880	0.170	0.060	0.010
Analyses	9	9	9	9	9	9	9	9	9	9	8
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	1
					Spring						
Maximum	85,300	330	5.400	1.500	0.740	0.100	0.100	1.060	0.290	0.060	0.030
Minimum	11,200	13	2.800	0.210	0.200	0.020	0.020 1/	0.480	0.040	0.020 1/	0.010
Average	37,800	101	3.990	0.650	0.400	0.050	0.040	0.780	0.090	0.030	0.010
Median	36,900	56	4.200	0.620	0.370	0.050	0.040	0.810	0.070	0.040	0.010
Analyses	25	25	25	25	25	25	25	25	25	25	16
< Limit 2/	0	0	0	0	0	0	1	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	9
					Summer						
Maximum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Minimum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Average	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Median	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Analyses	0	0	0	0	0	0	0	0	0	0	0
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
					Fall						
Maximum	31,700	126	5.700	1.700	1.000	0.080	0.080	0.990	0.160	0.070	0.030
Minimum	3,850	8	1.100	0.380	0.200	0.030	0.030	0.640	0.080	0.040	0.010
Average	18,100	54	3.420	0.890	0.440	0.050	0.040	0.730	0.100	0.040	0.010
Median	17,200	42	3.600	0.850	0.440	0.050	0.040	0.680	0.100	0.050	0.010
Analyses	7	7	7	7	7	7	7	7	7	7	7
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, Susquehanna River at Towanda, Pa., January 1989 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	66,000	313	7.100	1.900	1.000	0.140	0.140	1.100	0.190	0.070	0.020
Minimum	3,000	3	2.600	0.220	0.200	0.020 1/	0.020 1/	0.740	0.020	0.020 1/	0.010
Average	16,500	65	4.740	1.010	0.580	0.080	0.080	0.940	0.110	0.040	0.010
Median	10,600	30	5.050	0.895	0.655	0.095	0.095	0.950	0.115	0.055	0.010
Analyses 2/	12	12	12	12	12	12	12	12	12	12	9
< Limit	0	0	0	0	0	1	1	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	3
						Spring					
Maximum	85,300	330	5.400	1.500	0.740	0.100	0.100	1.060	0.290	0.060	0.030
Minimum	6,000	5	2.800	0.210	0.200	0.020 1/	0.020 1/	0.480	0.040	0.020 1/	0.010
Average	35,800	95	3.950	0.640	0.390	0.050	0.040	0.790	0.090	0.030	0.010
Median	34,500	55	4.000	0.560	0.360	0.050	0.040	0.820	0.070	0.040	0.010
Analyses 2/	27	27	27	27	27	27	27	27	27	27	18
< Limit	0	0	0	0	0	1	2	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	9
						Summer					
Maximum	4,400	17	3.800	0.450	0.340	0.030	0.030	1.190	0.100	0.100	0.040
Minimum	913	5	3.000	0.280	0.280	0.020 1/	0.020 1/	0.860	0.060	0.040	0.020
Average	2,400	9	3.430	0.340	0.290	0.020	0.020	0.980	0.080	0.060	0.030
Median	1,930	6	3.500	0.300	0.280	0.030	0.030	0.900	0.090	0.050	0.030
Analyses 2/	3	3	3	3	3	3	3	3	3	3	2
< Limit	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	1
						Fall					
Maximum	31,700	126	6.200	1.700	1.000	0.110	0.110	1.320	0.160	0.070	0.030
Minimum	1,610	3	1.100	0.230	0.200 1/	0.020 1/	0.020 1/	0.640	0.050	0.040	0.010
Average	4,700	45	3.690	0.720	0.360	0.050	0.050	0.810	0.090	0.040	0.010
Median	13,500	29	3.500	0.565	0.280	0.055	0.040	0.765	0.095	0.040	0.010
Analyses 2/	10	9	10	10	10	10	10	10	10	10	10
< Limit	0	0	0	0	1	1	1	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Susquehanna River at Towanda, Pa., January 1989 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
					Base Flow						
Maximum	14,900	32	6.200	0.560	0.340	0.110	0.110	1.320	0.100	0.100	0.040
Minimum	913	3	2.600	0.220	0.200 1/	0.020 1/	0.020 1/	0.780	0.020	0.020 1/	0.010
Average	5,800	11	3.540	0.350	0.230	0.040	0.040	0.980	0.050	0.040	0.010
Median	4,450	6	3.300	0.300	0.230	0.030	0.030	0.900	0.060	0.040	0.015
Analyses	11	10	11	11	11	11	11	11	11	11	8
< Limit 2/	0	0	0	0	1	3	3	0	0	1	0
Missing	0	1	0	0	0	0	0	0	0	0	3
					Stormflow						
Maximum	85,300	330	7.100	1.900	1.000	0.140	0.140	1.060	0.290	0.070	0.030
Minimum	3,850	3	1.100	0.210	0.200	0.020 1/	0.020 1/	0.480	0.040	0.020 1/	0.010
Average	30,600	89	4.190	0.820	0.470	0.060	0.050	0.800	0.100	0.040	0.010
Median	26,600	56	4.200	0.770	0.440	0.060	0.050	0.810	0.090	0.040	0.010
Analyses	41	41	41	41	41	41	41	41	41	41	31
< Limit 2/	0	0	0	0	0	1	2	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	10
					Combined Base Flow and Stormflow						
Maximum	85,300	330	7.100	1.900	1.000	0.140	0.140	1.320	0.290	0.100	0.040
Minimum	913	3	1.100	0.210	0.200 1/	0.020 1/	0.020 1/	0.480	0.020	0.020 1/	0.010
Average	25,400	74	4.050	0.720	0.420	0.050	0.050	0.840	0.090	0.040	0.010
Median	20,700	42	3.850	0.605	0.365	0.060	0.045	0.840	0.085	0.040	0.010
Analyses	52	51	52	52	52	52	52	52	52	52	39
< Limit 2/	0	0	0	0	1	4	5	0	0	2	0
Missing	0	1	0	0	0	0	0	0	0	0	13

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Susquehanna River at Danville, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	25,900	29	6.700	1.320	1.120	0.310	0.310	1.400	0.110	0.080	0.030
Minimum	3,600	4	2.500	0.200	0.180	0.020	0.020	0.900	0.040	0.010 1/	0.010 1/
Average	10,700	13	3.600	0.490	0.370	0.110	0.110	1.140	0.060	0.020	0.010
Median	8,340	11	3.150	0.340	0.240	0.088	0.088	1.170	0.060	0.020	0.010 1/
Analyses	14	14	14	14	13	14	14	14	14	14	11
< Limit 2/	0	0	0	0	0	0	0	0	0	2	1
Missing	0	0	0	0	1	0	0	0	0	0	3
						Spring					
Maximum	23,200	40	4.400	2.200	1.200	0.120	0.120	1.020	0.150	0.080	0.050
Minimum	3,140	7	2.400	0.230	0.200	0.020 1/	0.020 1/	0.260	0.040	0.010 1/	0.010 1/
Average	11,900	20	3.510	0.780	0.530	0.040	0.040	0.630	0.070	0.030	0.010
Median	9,880	18	3.650	0.685	0.370	0.030	0.020	0.570	0.075	0.030	0.015
Analyses	12	11	12	12	12	12	12	12	12	12	8
< Limit 2/	0	0	0	0	0	2	2	0	0	2	2
Missing	0	1	0	0	0	0	0	0	0	0	4
						Summer					
Maximum	10,000	38	11.000	0.900	0.620	0.100	0.100	0.840	0.200	0.050	0.020
Minimum	1,630	5	2.900	0.290	0.200	0.020 1/	0.020 1/	0.060	0.010 1/	0.010 1/	0.010 1/
Average	4,260	16	5.070	0.590	0.360	0.030	0.030	0.510	0.080	0.020	0.000
Median	3,110	12	4.150	0.550	0.345	0.040	0.035	0.540	0.080	0.030	0.010 1/
Analyses	14	13	12	14	14	14	14	13	14	14	7
< Limit 2/	0	0	0	0	0	1	2	0	1	1	2
Missing	0	1	2	0	0	0	0	1	0	0	7
						Fall					
Maximum	19,600	39	6.700	0.880	0.740	0.120	0.120	1.250	0.170	0.050	0.020
Minimum	1,900	1	2.200	0.200	0.200 1/	0.020 1/	0.020 1/	0.440	0.050	0.010 1/	0.010
Average	9,680	11	3.650	0.450	0.340	0.060	0.060	0.810	0.070	0.020	0.010
Median	9,430	8	3.400	0.450	0.310	0.067	0.067	0.870	0.055	0.030	0.010
Analyses	14	13	14	14	14	14	14	14	14	14	11
< Limit 2/	0	0	0	0	1	1	1	0	0	1	0
Missing	0	1	0	0	0	0	0	0	0	0	3

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Susquehanna River at Danville, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	176,000	766	5.000	3.000	1.200	0.175	0.175	1.220	0.440	0.180	0.170
Minimum	7,490	4	2.500	0.470	0.320	0.020	0.020 [1]	0.740	0.050	0.020	0.010
Average	50,300	148	3.890	1.130	0.680	0.090	0.080	0.970	0.140	0.040	0.020
Median	36,000	60	3.750	1.060	0.675	0.100	0.093	0.960	0.125	0.040	0.010
Analyses	24	24	24	24	24	24	24	24	24	24	15
< Limit [2]	0	0	0	0	0	0	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	9
Spring											
Maximum	104,000	464	10.700	2.600	0.880	0.160	0.140	0.990	0.420	0.090	0.050
Minimum	9,130	11	1.600	0.200	0.200 [1]	0.020 [1]	0.020 [1]	0.420	0.020	0.020 [1]	0.010
Average	48,800	124	4.600	0.790	0.450	0.060	0.060	0.730	0.140	0.030	0.010
Median	40,000	73	4.600	0.700	0.470	0.060	0.060	0.740	0.110	0.040	0.010
Analyses	63	63	62	60	60	63	61	63	63	63	28
< Limit [2]	0	0	0	0	2	4	4	0	0	1	0
Missing	0	0	1	3	3	0	2	0	0	0	35
Summer											
Maximum	15,900	182	4.900	1.220	0.610	0.125	0.125	1.080	0.390	0.030	0.010
Minimum	3,740	24	2.000	0.550	0.320	0.020	0.020	0.560	0.110	0.020	0.010
Average	9,020	72	3.020	0.930	0.470	0.090	0.080	0.860	0.180	0.020	0.000
Median	8,420	65	2.900	0.980	0.500	0.100	0.095	0.860	0.150	0.030	0.010
Analyses	9	8	9	9	9	9	9	9	9	9	9
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0
Fall											
Maximum	41,800	122	15.000	1.900	1.300	0.115	0.115	1.500	0.190	0.050	0.020
Minimum	7,140	20	2.400	0.380	0.200	0.030	0.030	0.680	0.060	0.030	0.010
Average	30,000	69	4.860	0.880	0.480	0.060	0.050	0.930	0.100	0.030	0.010
Median	33,000	79	4.000	0.700	0.380	0.060	0.060	0.880	0.090	0.030	0.010
Analyses	13	13	13	13	13	13	13	13	13	13	5
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	8

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[1] analytical detection limit

[2] number of analyses below detection limit

Seasonal combined flow nutrient statistics, Susquehanna River at Danville, Pa. January 1985 to December 1989

Statistic	Flow cfs	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
		mg/l									
						Winter					
Maximum	175,800	766	6.700	3.000	1.200	0.310	0.310	1.400	0.440	0.180	0.170
Minimum	3,600	4	2.500	0.200	0.180	0.020	0.020 1/	0.740	0.040	0.010 1/	0.010 1/
Average	35,700	98	3.780	0.900	0.580	0.100	0.090	1.030	0.110	0.030	0.010
Median	18,700	28	3.700	0.850	0.540	0.097	0.088	1.020	0.075	0.035	0.010 1/
Analyses	38	38	38	38	37	38	38	38	38	38	26
< Limit 2/	0	0	0	0	0	0	1	0	0	2	1
Missing	0	0	0	0	1	0	0	0	0	0	12
						Spring					
Maximum	103,800	464	10.700	2.600	1.200	0.160	0.140	1.020	0.420	0.090	0.050
Minimum	3,140	7	1.600	0.200	0.200 1/	0.020 1/	0.020 1/	0.260	0.020	0.010 1/	0.010 1/
Average	42,900	108	4.420	0.780	0.470	0.060	0.050	0.720	0.130	0.030	0.010
Median	32,500	69	4.250	0.700	0.430	0.060	0.060	0.740	0.100	0.040	0.010 1/
Analyses	75	74	74	72	72	75	73	75	75	75	36
< Limit 2/	0	0	0	0	2	6	6	0	0	3	2
Missing	0	1	1	3	3	0	2	0	0	0	39
						Summer					
Maximum	15,900	182	11.000	1.220	0.620	0.125	0.125	1.080	0.390	0.050	0.020
Minimum	1,630	5	2.000	0.290	0.200	0.020 1/	0.020 1/	0.060	0.010 1/	0.010 1/	0.010 1/
Average	6,120	38	4.190	0.720	0.400	0.050	0.050	0.650	0.120	0.020	0.000
Median	4,410	24	3.400	0.660	0.420	0.050	0.040	0.775	0.100	0.030	0.010 1/
Analyses	23	21	21	23	23	23	23	22	23	23	16
< Limit 2/	0	0	0	0	0	1	2	0	1	1	2
Missing	0	2	2	0	0	0	0	1	0	0	7
						Fall					
Maximum	41,800	122	15.000	1.900	1.300	0.120	0.120	1.500	0.190	0.050	0.020
Minimum	1,900	1	2.200	0.200	0.200 1/	0.020 1/	0.020 1/	0.440	0.050	0.010 1/	0.010
Average	19,500	40	4.230	0.660	0.410	0.060	0.060	0.870	0.080	0.030	0.010
Median	15,600	30	3.700	0.520	0.340	0.065	0.065	0.880	0.070	0.030	0.010
Analyses	27	26	27	27	27	27	27	27	27	27	16
< Limit 1/	0	0	0	0	1	1	1	0	0	1	0
Missing	0	1	0	0	0	0	0	0	0	0	11

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Susquehanna River at Danville, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
					Base Flow						
Maximum	25,900	40	11.000	2.200	1.200	0.310	0.310	1.400	0.200	0.080	0.050
Minimum	1,630	1	2.200	0.200	0.200 1/	0.020 1/	0.020 1/	0.060	0.010 1/	0.010 1/	0.010 1/
Average	9,040	15	3.930	0.570	0.400	0.060	0.060	0.780	0.070	0.020	0.010
Median	7,730	12	3.600	0.515	0.340	0.053	0.045	0.800	0.065	0.030	0.010 1/
Analyses	54	51	52	54	53	54	54	53	54	54	37
< Limit 2/	0	0	0	0	1	4	5	0	1	6	5
Missing	0	3	2	0	1	0	0	1	0	0	17
					Stormflow						
Maximum	175,800	766	15.000	3.000	1.300	0.175	0.175	1.500	0.440	0.180	0.170
Minimum	3,740	4	1.600	0.200	0.200 1/	0.020 1/	0.020 1/	0.420	0.020	0.020 1/	0.010
Average	43,600	119	4.340	0.890	0.510	0.070	0.060	0.820	0.140	0.030	0.010
Median	33,900	72	4.050	0.795	0.510	0.080	0.070	0.800	0.110	0.040	0.010
Analyses	109	108	108	106	106	109	107	109	109	109	57
< Limit 2/	0	0	0	0	2	4	5	0	0	1	0
Missing	0	1	1	3	3	0	2	0	0	0	52
					Combined Base Flow and Stormflow						
Maximum	176,000	766	15.000	3.000	1.300	0.310	0.310	1.500	0.440	0.180	0.170
Minimum	1,630	1	1.600	0.200	0.200 1/	0.020 1/	0.020 1/	0.060	0.010 1/	0.010 1/	0.010 1/
Average	32,100	85	4.210	0.780	0.470	0.070	0.060	0.810	0.110	0.030	0.010
Median	21,200	42	3.900	0.700	0.440	0.070	0.065	0.800	0.090	0.030	0.010 1/
Analyses	163	159	160	160	159	163	161	162	163	163	94
< Limit 2/	0	0	0	0	3	8	10	0	1	7	5
Missing	0	4	3	3	4	0	2	1	0	0	69

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, W. Branch Susquehanna River at Lewisburg, Pa., January 1985 to December 1989

Statistic	Flow cfs	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
		mg/l									
Winter											
Maximum	19,700	15	3.900	1.100	0.600	0.230	0.230	1.200	0.080	0.040	0.030
Minimum	3,800	2	1.000	0.200	0.200	0.020	0.020	0.600	0.010 1/	0.010 1/	0.010 1/
Average	9,080	8	2.030	0.400	0.320	0.070	0.060	0.850	0.030	0.020	0.010
Median	7,920	7	1.700	0.330	0.300	0.060	0.057	0.860	0.040	0.020	0.010 1/
Analyses 2/	14	14	14	14	13	14	14	14	14	14	11
< Limit	0	0	0	0	0	0	0	0	1	2	2
Missing	0	0	0	0	1	0	0	0	0	0	3
Spring											
Maximum	18,000	18	7.900	0.950	0.910	0.080	0.080	0.820	0.090	0.060	0.010
Minimum	2,200	2	1.000	0.200	0.200 1/	0.020 1/	0.020 1/	0.300	0.010 1/	0.010 1/	0.010 1/
Average	9,050	7	2.140	0.410	0.270	0.020	0.020	0.580	0.040	0.020	0.000
Median	8,880	7	1.500	0.290	0.230	0.030	0.020	0.600	0.050	0.020	0.010 1/
Analyses 2/	13	12	13	13	12	13	13	13	13	13	9
< Limit	0	0	0	0	1	2	2	0	2	4	4
Missing	0	1	0	0	1	0	0	0	0	0	4
Summer											
Maximum	11,600	30	4.400	0.850	0.780	0.125	0.125	1.030	0.190	0.060	0.030
Minimum	730	1	1.600	0.230	0.200	0.020 1/	0.020 1/	0.500	0.010 1/	0.010 1/	0.010
Average	3,530	8	2.450	0.480	0.380	0.050	0.030	0.760	0.060	0.040	0.010
Median	2,570	5	2.500	0.470	0.360	0.045	0.028	0.730	0.055	0.045	0.010
Analyses 2/	12	13	13	14	14	14	14	14	14	14	9
< Limit	0	0	0	0	0	1	2	0	1	2	0
Missing	2	1	1	0	0	0	0	0	0	0	5
Fall											
Maximum	13,500	24	3.300	0.620	0.500	0.070	0.070	0.950	0.100	0.080	0.040
Minimum	1,870	1	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.420	0.020	0.020 1/	0.010
Average	6,880	7	1.840	0.310	0.260	0.030	0.030	0.670	0.040	0.030	0.010
Median	4,930	5	1.900	0.250	0.200 1/	0.035	0.035	0.670	0.040	0.030	0.010
Analyses 2/	14	11	14	14	14	14	14	14	14	14	9
< Limit	0	0	2	1	1	1	2	0	0	2	0
Missing	0	3	0	0	0	0	0	0	0	0	5

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, W. Branch Susquehanna River at Lewisburg, Pa., January 1985 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
						Winter					
Maximum	100,000	503	4.100	1.620	0.710	0.450	0.450	0.820	0.230	0.060	0.010
Minimum	10,000	13	1.100	0.240	0.180	0.020	0.020	0.580	0.020	0.020 1/	0.010
Average	38,300	93	2.060	0.780	0.410	0.050	0.050	0.690	0.070	0.020	0.000
Median	34,200	44	1.900	0.650	0.390	0.040	0.028	0.720	0.050	0.030	0.010
Analyses	24	24	24	24	24	24	24	24	24	24	6
< Limit 2/	0	0	0	0	0	0	0	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	18
						Spring					
Maximum	83,000	342	9.300	1.610	0.700	0.120	0.120	0.780	0.230	0.170	0.010
Minimum	6,240	3	1.000 1/	0.200	0.200 1/	0.020 1/	0.020 1/	0.360	0.020 1/	0.020 1/	0.010
Average	34,500	50	2.380	0.570	0.340	0.040	0.040	0.580	0.070	0.030	0.000
Median	30,800	32	2.000	0.495	0.320	0.045	0.040	0.600	0.060	0.030	0.010
Analyses	62	62	62	62	62	62	62	62	62	62	10
< Limit 2/	0	0	1	0	1	5	7	0	1	3	0
Missing	0	0	0	0	0	0	0	0	0	0	52
						Summer					
Maximum	2,460	7	3.700	0.460	0.380	0.080	0.065	0.840	0.190	0.090	0.080
Minimum	2,400	4	1.000 1/	0.300	0.200	0.055	0.040	0.640	0.040	0.020	0.010
Average	2,430	6	2.120	0.360	0.270	0.060	0.050	0.720	0.080	0.040	0.030
Median	2,430	6	2.150	0.340	0.260	0.057	0.055	0.710	0.055	0.025	0.015
Analyses	3	3	4	4	4	4	4	4	4	4	4
< Limit 2/	0	0	1	0	0	0	0	0	0	0	0
Missing	1	1	0	0	0	0	0	0	0	0	0
						Fall					
Maximum	30,700	120	9.600	1.700	1.600	0.060	0.060	1.080	0.260	0.100	0.070
Minimum	6,570	6	1.300	0.180	0.180	0.020 1/	0.020 1/	0.740	0.030	0.020	0.010
Average	19,600	42	3.190	0.620	0.440	0.030	0.030	0.890	0.080	0.040	0.020
Median	21,200	25	1.700	0.330	0.280	0.040	0.040	0.900	0.040	0.030	0.010
Analyses	11	11	11	11	11	11	11	11	11	11	8
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	3

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, W. Branch Susquehanna River at Lewisburg, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	100,000	503	4.100	1.620	0.710	0.450	0.450	1.200	0.230	0.060	0.030
Minimum	3,800	2	1.000	0.200	0.180	0.020	0.020	0.580	0.010 1/	0.010 1/	0.010 1/
Average	27,500	61	2.050	0.640	0.380	0.060	0.050	0.750	0.060	0.020	0.010
Median	19,000	27	1.800	0.545	0.380	0.040	0.040	0.740	0.040	0.025	0.010 1/
Analyses	38	38	38	38	37	38	38	38	38	38	17
< Limit 2/	0	0	0	0	0	0	0	0	1	3	2
Missing	0	0	0	0	1	0	0	0	0	0	21
						Spring					
Maximum	83,000	342	9.300	1.610	0.910	0.120	0.120	0.820	0.230	0.170	0.010
Minimum	2,200	2	1.000 1/	0.200	0.200 1/	0.020 1/	0.020 1/	0.300	0.010 1/	0.010 1/	0.010 1/
Average	30,100	43	2.340	0.540	0.330	0.040	0.040	0.580	0.060	0.030	0.000
Median	25,800	28	2.000	0.470	0.280	0.040	0.030	0.600	0.060	0.030	0.010 1/
Analyses	75	74	75	75	74	75	75	75	75	75	19
< Limit 2/	0	0	1	0	2	7	9	0	3	7	4
Missing	0	1	0	0	1	0	0	0	0	0	56
						Summer					
Maximum	11,600	30	4.400	0.850	0.780	0.125	0.125	1.030	0.190	0.090	0.080
Minimum	730	1	1.000 1/	0.230	0.200	0.020 1/	0.020 1/	0.500	0.010 1/	0.010 1/	0.010
Average	3,310	8	2.370	0.450	0.350	0.050	0.040	0.750	0.070	0.040	0.020
Median	2,430	5	2.500	0.400	0.345	0.055	0.035	0.720	0.055	0.040	0.010
Analyses	15	16	17	18	18	18	18	18	18	18	13
< Limit 2/	0	0	1	0	0	1	2	0	1	2	0
Missing	3	2	1	0	0	0	0	0	0	0	5
						Fall					
Maximum	30,700	120	9.600	1.700	1.600	0.070	0.070	1.080	0.260	0.100	0.070
Minimum	1,870	1	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.420	0.020	0.020 1/	0.010
Average	12,500	24	2.430	0.450	0.340	0.030	0.030	0.770	0.060	0.030	0.010
Median	11,500	11	1.900	0.320	0.200 1/	0.040	0.040	0.760	0.040	0.030	0.010
Analyses	25	22	25	25	25	25	25	25	25	25	17
< Limit 2/	0	0	2	1	1	2	3	0	0	2	0
Missing	0	3	0	0	0	0	0	0	0	0	8

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, W. Branch Susquehanna River at Lewisburg, Pa., January 1985 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
Base Flow											
Maximum	19,700	30	7.900	1.100	0.910	0.230	0.230	1.200	0.190	0.080	0.040
Minimum	730	1	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.300	0.010 1/	0.010 1/	0.010 1/
Average	7,240	7	2.110	0.400	0.310	0.040	0.040	0.720	0.050	0.030	0.010
Median	6,440	6	1.900	0.340	0.260	0.040	0.030	0.680	0.040	0.030	0.010
Analyses	53	50	54	55	53	55	55	55	55	55	38
< Limit 2/	0	0	2	1	2	4	6	0	4	10	6
Missing	2	5	1	0	2	0	0	0	0	0	17
Stormflow											
Maximum	100,000	503	9.600	1.700	1.600	0.450	0.450	1.080	0.260	0.170	0.080
Minimum	2,410	3	1.000 1/	0.180	0.200 1/	0.020 1/	0.020 1/	0.360	0.020 1/	0.020 1/	0.010
Average	32,800	58	2.380	0.610	0.370	0.050	0.040	0.650	0.070	0.030	0.010
Median	28,100	32	2.000	0.500	0.360	0.040	0.040	0.640	0.050	0.030	0.010
Analyses	100	100	101	101	101	101	101	101	101	101	28
< Limit 2/	0	0	2	0	1	6	8	0	1	4	0
Missing	1	1	0	0	0	0	0	0	0	0	73
Combined Base Flow and Stormflow											
Maximum	100,000	503	9.600	1.700	1.600	0.450	0.450	1.200	0.260	0.170	0.080
Minimum	730	1	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.300	0.010 1/	0.010 1/	0.010 1/
Average	24,000	41	2.290	0.540	0.350	0.040	0.040	0.670	0.060	0.030	0.010
Median	18,600	19	2.000	0.445	0.310	0.040	0.040	0.660	0.050	0.030	0.010
Analyses	153	150	155	156	154	156	156	156	156	156	66
< Limit 2/	0	0	4	1	3	10	14	0	5	14	6
Missing	3	6	1	0	2	0	0	0	0	0	90

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Juniata River at Newport, Pa., January 1985 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
					Winter						
Maximum	7,770	80	6.900	0.800	0.500	0.090	0.070	1.900	0.130	0.060	0.060
Minimum	1,600	1	1.800	0.200	0.200	0.020 1/	0.020 1/	1.120	0.020	0.010 1/	0.010
Average	3,410	12	3.390	0.400	0.280	0.030	0.030	1.510	0.050	0.030	0.020
Median	3,070	5	2.800	0.370	0.230	0.030	0.030	1.510	0.055	0.040	0.020
Analyses 2/	14	13	14	14	13	14	14	14	14	14	12
< Limit	0	0	0	0	0	1	2	0	0	1	0
Missing	0	1	0	0	1	0	0	0	0	0	2
					Spring						
Maximum	7,260	41	7.800	1.300	1.060	0.090	0.080	1.600	0.120	0.090	0.060
Minimum	1,530	6	1.500	0.310	0.200	0.020 1/	0.020 1/	0.540	0.040	0.010 1/	0.010
Average	3,790	17	3.500	0.620	0.460	0.030	0.020	1.280	0.070	0.040	0.020
Median	3,260	15	2.900	0.610	0.400	0.020 1/	0.020	1.400	0.070	0.040	0.020
Analyses 2/	13	12	13	12	11	13	13	13	13	13	11
< Limit	0	0	0	0	0	1	2	0	0	1	0
Missing	0	1	0	1	2	0	0	0	0	0	2
					Summer						
Maximum	2,750	27	7.500	0.880	0.480	0.090	0.060	1.460	0.210	0.130	0.870
Minimum	555	4	2.700	0.210	0.200	0.020	0.020 1/	0.040 1/	0.010 1/	0.010 1/	0.010 1/
Average	1,210	10	4.570	0.480	0.350	0.030	0.020	0.740	0.090	0.060	0.130
Median	1,010	6	4.150	0.440	0.390	0.035	0.030	0.700	0.090	0.060	0.040
Analyses 2/	13	13	12	13	13	12	12	13	13	13	8
< Limit	0	0	0	0	0	0	3	2	1	1	1
Missing	0	0	1	0	0	1	1	0	0	0	5
					Fall						
Maximum	4,880	13	13.500	0.720	0.550	0.080	0.080	1.720	0.200	0.150	0.100
Minimum	728	1	1.600	0.200	0.200	0.020 1/	0.020 1/	0.780	0.040	0.020	0.010
Average	2,210	5	4.300	0.390	0.340	0.020	0.020	1.220	0.070	0.050	0.030
Median	1,710	3	3.350	0.350	0.305	0.020	0.020	1.205	0.060	0.040	0.030
Analyses 2/	14	14	14	14	14	14	14	14	14	14	13
< Limit	0	0	0	0	0	2	2	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	1

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Juniata River at Newport, Pa., January 1985 to December 1989

Statistic	Flow cfs	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
		mg/l									
					Winter						
Maximum	28,700	113	16.600	1.200	0.710	0.100	0.090	1.980	0.260	0.090	0.020
Minimum	2,920	5	1.700	0.200	0.160	0.020	0.020	1.000	0.040	0.030	0.010
Average	12,300	47	4.260	0.600	0.380	0.040	0.040	1.510	0.080	0.040	0.010
Median	8,580	36	3.250	0.635	0.350	0.043	0.040	1.430	0.075	0.040	0.020
Analyses	28	27	26	28	28	28	28	28	28	28	21
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	1	2	0	0	0	0	0	0	0	7
					Spring						
Maximum	42,400	517	18.100	1.910	0.810	0.190	0.165	1.760	0.500	0.120	0.050
Minimum	2,900	12	1.500	0.200	0.200	0.020	0.020 [1]	0.860	0.050	0.020	0.010
Average	17,700	96	5.580	0.710	0.390	0.060	0.060	1.250	0.130	0.040	0.010
Median	13,200	48	4.000	0.690	0.380	0.057	0.055	1.225	0.110	0.040	0.010
Analyses	62	62	62	62	62	62	62	62	62	62	39
< Limit [2]	0	0	0	0	0	0	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	23
					Summer						
Maximum	41,300	375	8.000	1.840	1.000	0.120	0.110	1.780	0.400	0.100	0.060
Minimum	1,080	9	1.300	0.330	0.210	0.030	0.030	0.860	0.080	0.040	0.010
Average	10,100	89	3.600	0.960	0.540	0.070	0.060	1.420	0.150	0.060	0.020
Median	3,350	56	3.100	0.950	0.535	0.080	0.073	1.450	0.120	0.070	0.020
Analyses	28	28	28	28	28	28	28	28	28	28	24
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	4
					Fall						
Maximum	9,880	104	5.800	2.200	0.950	0.070	0.070	1.820	0.190	0.080	0.060
Minimum	2,670	12	2.300	0.380	0.250	0.020	0.020	1.190	0.060	0.040	0.010
Average	5,790	52	3.820	0.700	0.490	0.050	0.050	1.550	0.110	0.060	0.030
Median	5,890	41	3.900	0.580	0.500	0.055	0.055	1.540	0.120	0.060	0.040
Analyses	21	19	21	21	21	21	21	21	21	21	20
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	2	0	0	0	0	0	0	0	0	1

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[1] analytical detection limit

[2] number of analyses below detection limit

Seasonal combined flow nutrient statistics, Juniata River at Newport, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	28,700	113	16.600	1.200	0.710	0.100	0.090	1.980	0.260	0.090	0.060
Minimum	1,600	1	1.700	0.200	0.160	0.020 1/	0.020 1/	1.000	0.020	0.010 1/	0.010
Average	9,310	35	3.950	0.530	0.350	0.040	0.030	1.510	0.070	0.040	0.020
Median	5,740	22	3.050	0.475	0.310	0.040	0.040	1.490	0.060	0.040	0.020
Analyses	42	40	40	42	41	42	42	42	42	42	33
< Limit 2/	0	0	0	0	0	1	2	0	0	1	0
Missing	0	2	2	0	1	0	0	0	0	0	9
Spring											
Maximum	42,400	517	18.100	1.910	1.060	0.190	0.165	1.760	0.500	0.120	0.060
Minimum	1,530	6	1.500	0.200	0.200	0.020 1/	0.020 1/	0.540	0.040	0.010 1/	0.010
Average	15,300	83	5.220	0.690	0.400	0.050	0.050	1.260	0.120	0.040	0.010
Median	12,300	36	3.900	0.675	0.380	0.050	0.050	1.230	0.110	0.040	0.010
Analyses	75	74	75	74	73	75	75	75	75	75	50
< Limit 2/	0	0	0	0	0	1	3	0	0	1	0
Missing	0	1	0	1	2	0	0	0	0	0	25
Summer											
Maximum	41,300	375	8.000	1.840	1.000	0.120	0.110	1.780	0.400	0.130	0.870
Minimum	555	4	1.300	0.210	0.200	0.020	0.020 1/	0.040 1/	0.010 1/	0.010 1/	0.010 1/
Average	7,250	64	3.890	0.800	0.480	0.060	0.050	1.200	0.130	0.060	0.050
Median	2,440	35	3.450	0.720	0.420	0.070	0.060	1.390	0.110	0.070	0.020
Analyses	41	41	40	41	41	40	40	41	41	41	32
< Limit 2/	0	0	0	0	0	0	3	2	1	1	1
Missing	0	0	1	0	0	1	1	0	0	0	9
Fall											
Maximum	9,880	104	13.500	2.200	0.950	0.080	0.080	1.820	0.200	0.150	0.100
Minimum	728	1	1.600	0.200	0.200	0.020 1/	0.020 1/	0.780	0.040	0.020	0.010
Average	4,360	32	4.010	0.570	0.430	0.040	0.040	1.420	0.090	0.060	0.030
Median	4,440	17	3.700	0.500	0.380	0.050	0.050	1.500	0.090	0.060	0.040
Analyses	35	33	35	35	35	35	35	35	35	35	33
< Limit 2/	0	0	0	0	0	2	2	0	0	0	0
Missing	0	2	0	0	0	0	0	0	0	0	2

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Juniata River at Newport, Pa., January 1985 to December 1989

Statistic	Flow cfs	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
		mg/l									
Base Flow											
Maximum	7,770	80	13.500	1.300	1.060	0.090	0.080	1.900	0.210	0.150	0.870
Minimum	555	1	1.500	0.200	0.200	0.020 1/	0.020 1/	0.040 1/	0.010 1/	0.010 1/	0.010 1/
Average	2,660	11	3.920	0.470	0.350	0.030	0.020	1.200	0.070	0.040	0.040
Median	2,320	6	3.400	0.420	0.300	0.020	0.020	1.360	0.060	0.040	0.025
Analyses	54	52	53	53	51	53	53	54	54	54	44
< Limit 2/	0	0	0	0	0	4	9	2	1	3	1
Missing	0	2	1	1	3	1	1	0	0	0	10
Stormflow											
Maximum	42,400	517	18.100	2.200	1.000	0.190	0.165	1.980	0.500	0.120	0.060
Minimum	1,080	5	1.300	0.200	0.160	0.020	0.020 1/	0.860	0.040	0.020	0.010
Average	13,300	79	4.650	0.730	0.430	0.060	0.050	1.380	0.120	0.050	0.020
Median	9,880	46	3.500	0.670	0.400	0.060	0.055	1.390	0.110	0.050	0.020
Analyses	139	136	137	139	139	139	139	139	139	139	104
< Limit 2/	0	0	0	0	0	0	1	0	0	0	0
Missing	0	3	2	0	0	0	0	0	0	0	35
Combined Base Flow and Stormflow											
Maximum	42,400	517	18.100	2.200	1.060	0.190	0.165	1.980	0.500	0.150	0.870
Minimum	555	1	1.300	0.200	0.160	0.020 1/	0.020 1/	0.040 1/	0.010 1/	0.010 1/	0.010 1/
Average	10,300	60	4.450	0.660	0.410	0.050	0.040	1.330	0.110	0.050	0.030
Median	6,290	34	3.500	0.595	0.380	0.050	0.050	1.390	0.100	0.050	0.020
Analyses	193	188	190	192	190	192	192	193	193	193	148
< Limit 2/	0	0	0	0	0	4	10	2	1	3	1
Missing	0	5	3	1	3	1	1	0	0	0	45

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Sherman Creek at Shermans Dale, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	686	24	4.600	0.700	0.440	0.060	0.050	2.000	0.070	0.040	0.010
Minimum	46.6	1	1.300	0.200	0.200	0.020 1/	0.020 1/	1.100	0.010 1/	0.010 1/	0.010 1/
Average	241	6	2.700	0.330	0.260	0.020	0.020	1.550	0.020	0.020	0.000
Median	193	5	2.700	0.300	0.210	0.020 1/	0.020 1/	1.560	0.020	0.020	0.010 1/
Analyses	13	13	13	13	12	13	13	13	13	13	5
< Limit 2/	0	0	0	0	0	2	2	0	3	3	1
Missing	0	0	0	0	1	0	0	0	0	0	8
						Spring					
Maximum	464	28	6.000	2.600	1.100	0.100	0.090	1.560	0.080	0.060	0.030
Minimum	40.0	4	1.600	0.200	0.150	0.020 1/	0.020 1/	0.540	0.010 1/	0.010 1/	0.010 1/
Average	179	9	3.020	0.590	0.410	0.030	0.030	0.920	0.040	0.020	0.010
Median	185	8	2.550	0.410	0.385	0.023	0.023	0.850	0.040	0.030	0.010 1/
Analyses	14	14	14	14	14	14	14	14	14	14	9
< Limit 2/	0	0	0	0	0	2	2	0	2	3	4
Missing	0	0	0	0	0	0	0	0	0	0	5
						Summer					
Maximum	119	13	6.700	0.900	0.650	0.090	0.060	1.560	0.100	0.050	0.030
Minimum	24.9	4	2.100	0.200	0.200	0.020	0.020 1/	0.320	0.020	0.010 1/	0.010 1/
Average	46.4	7	3.800	0.460	0.360	0.040	0.030	0.760	0.050	0.030	0.010
Median	37.5	7	3.500	0.400	0.340	0.040	0.035	0.600	0.050	0.040	0.010 1/
Analyses	12	12	11	12	12	12	12	12	12	12	7
< Limit 2/	0	0	0	0	0	0	1	0	0	1	1
Missing	0	0	1	0	0	0	0	0	0	0	5
						Fall					
Maximum	332	13	5.600	0.600	0.560	0.080	0.080	1.860	0.070	0.050	0.020
Minimum	34.9	1	1.700	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.400	0.020	0.010 1/	0.010
Average	136	5	3.100	0.300	0.270	0.020	0.020	1.170	0.030	0.020	0.010
Median	80.0	6	2.700	0.280	0.260	0.020	0.020	1.180	0.030	0.020	0.010
Analyses	13	13	13	13	13	13	13	13	13	13	9
< Limit 2/	0	0	0	1	2	3	4	0	0	2	0
Missing	0	0	0	0	0	0	0	0	0	0	4

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Sherman Creek at Shermans Dale, Pa., January 1985 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
						Winter					
Maximum	1,610	93	12.900	1.260	0.680	0.170	0.160	2.280	0.200	0.080	0.040
Minimum	247	4	1.100	0.200	0.200	0.020 1/	0.020 1/	0.840	0.030	0.020	0.010
Average	701	34	4.430	0.510	0.370	0.060	0.060	1.600	0.070	0.040	0.020
Median	520	32	3.050	0.420	0.280	0.057	0.057	1.600	0.060	0.045	0.020
Analyses	26	26	26	26	26	26	26	26	26	26	13
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	13
						Spring					
Maximum	11,900	1,530	26.000	4.900	1.180	0.250	0.212	1.740	1.700	0.120	0.090
Minimum	201	6	1.300	0.200	0.160	0.020	0.020 1/	0.750	0.030	0.020 1/	0.020 1/
Average	2,180	139	6.600	0.960	0.500	0.070	0.060	1.250	0.160	0.040	0.020
Median	1,510	53	5.300	0.690	0.460	0.055	0.040	1.300	0.110	0.050	0.020 1/
Analyses	65	65	65	65	65	64	65	65	65	65	41
< Limit 2/	0	0	0	0	0	0	3	0	0	3	1
Missing	0	0	0	0	0	1	0	0	0	0	24
						Summer					
Maximum	7,070	885	11.000	2.240	0.800	0.200	0.180	2.050	0.510	0.140	0.090
Minimum	94.9	8	1.600	0.270	0.200	0.040	0.040	0.800	0.040	0.030	0.010
Average	1,550	130	4.930	0.900	0.520	0.090	0.070	1.580	0.160	0.060	0.020
Median	489	30	3.900	0.800	0.480	0.080	0.080	1.690	0.090	0.050	0.010
Analyses	25	25	25	25	25	25	25	25	25	25	24
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	1
						Fall					
Maximum	1,890	497	19.000	2.000	1.300	0.120	0.120	2.200	0.290	0.130	0.050
Minimum	165	5	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.800	0.040	0.030	0.010
Average	618	113	5.490	0.830	0.480	0.050	0.040	1.560	0.120	0.040	0.020
Median	464	75	5.200	0.630	0.400	0.055	0.050	1.480	0.130	0.050	0.025
Analyses	31	30	28	31	31	31	31	31	31	31	24
< Limit 2/	0	0	4	1	1	2	3	0	0	0	0
Missing	0	1	3	0	0	0	0	0	0	0	7

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, Sherman Creek at Shermans Dale, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	1,610	93	12.900	1.260	0.680	0.170	0.160	2.280	0.200	0.080	0.040
Minimum	46.6	1	1.100	0.200	0.200	0.020 1/	0.020 1/	0.840	0.010 1/	0.010 1/	0.010 1/
Average	548	25	3.860	0.450	0.340	0.040	0.040	1.580	0.060	0.030	0.010
Median	376	12	2.800	0.340	0.260	0.030	0.030	1.580	0.050	0.030	0.010 1/
Analyses	39	39	39	39	38	39	39	39	39	39	18
< Limit 2/	0	0	0	0	0	3	3	0	3	3	1
Missing	0	0	0	0	1	0	0	0	0	0	21
						Spring					
Maximum	11,900	1,530	26.000	4.900	1.180	0.250	0.212	1.740	1.700	0.120	0.090
Minimum	40.0	4	1.300	0.200	0.150	0.020 1/	0.020 1/	0.540	0.010 1/	0.010 1/	0.010 1/
Average	1,820	116	5.970	0.900	0.480	0.060	0.050	1.190	0.130	0.040	0.010
Median	1,260	35	4.900	0.620	0.420	0.040	0.040	1.240	0.090	0.050	0.010 1/
Analyses	79	79	79	79	79	78	79	79	79	79	50
< Limit 2/	0	0	0	0	0	2	5	0	2	6	5
Missing	0	0	0	0	0	1	0	0	0	0	29
						Summer					
Maximum	7,070	885	11.000	2.240	0.800	0.200	0.180	2.050	0.510	0.140	0.090
Minimum	24.9	4	1.600	0.200	0.200	0.020	0.020 1/	0.320	0.020	0.010 1/	0.010 1/
Average	1,060	90	4.590	0.760	0.470	0.070	0.060	1.320	0.120	0.050	0.020
Median	280	16	3.800	0.700	0.480	0.070	0.060	1.470	0.070	0.040	0.010 1/
Analyses	37	37	36	37	37	37	37	37	37	37	31
< Limit 2/	0	0	0	0	0	0	1	0	0	1	1
Missing	0	0	1	0	0	0	0	0	0	0	6
						Fall					
Maximum	1,890	497	19.000	2.000	1.300	0.120	0.120	2.200	0.290	0.130	0.050
Minimum	34.9	1	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.400	0.020	0.010 1/	0.010
Average	475	80	4.730	0.680	0.420	0.040	0.030	1.450	0.100	0.040	0.020
Median	308	19	4.200	0.500	0.325	0.040	0.040	1.470	0.070	0.030	0.020
Analyses	44	43	41	44	44	44	44	44	44	44	33
< Limit 2/	0	0	4	2	3	5	7	0	0	2	0
Missing	0	1	3	0	0	0	0	0	0	0	11

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Sherman Creek at Shermans Dale, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/1									
						Base Flow					
Maximum	686	28	6.700	2.600	1.100	0.100	0.090	2.000	0.100	0.060	0.030
Minimum	24.9	1	1.300	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.320	0.010 1/	0.010 1/	0.010 1/
Average	153	7	3.130	0.420	0.330	0.020	0.020	1.100	0.030	0.020	0.010
Median	124	6	2.700	0.345	0.300	0.020	0.020	1.090	0.040	0.030	0.010 1/
Analyses	52	52	51	52	51	52	52	52	52	52	30
< Limit 2/	0	0	0	1	2	7	9	0	5	9	6
Missing	0	0	1	0	1	0	0	0	0	0	22
						Stormflow					
Maximum	11,900	1,530	26.000	4.900	1.300	0.250	0.212	2.280	1.700	0.140	0.090
Minimum	94.9	4	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.750	0.030	0.020 1/	0.020 1/
Average	1,480	113	5.700	0.840	0.480	0.070	0.060	1.440	0.130	0.050	0.020
Median	810	47	4.650	0.640	0.470	0.060	0.055	1.450	0.090	0.050	0.020 1/
Analyses	147	146	144	147	147	146	147	147	147	147	102
< Limit 2/	0	0	4	1	1	3	7	0	0	3	1
Missing	0	1	3	0	0	1	0	0	0	0	45
						Combined Base Flow and Stormflow					
Maximum	11,900	1,530	26.000	4.900	1.300	0.250	0.212	2.280	1.700	0.140	0.090
Minimum	24.9	1	1.000 1/	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.320	0.010 1/	0.010 1/	0.010 1/
Average	1,130	85	5.030	0.730	0.440	0.050	0.050	1.350	0.110	0.040	0.020
Median	473	24	4.000	0.550	0.420	0.050	0.040	1.400	0.070	0.040	0.010 1/
Analyses	199	198	195	199	198	198	199	199	199	199	132
< Limit 2/	0	0	4	2	3	10	16	0	5	12	7
Missing	0	1	4	0	1	1	0	0	0	0	67

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Stony Creek near Dauphin, Pa., January 1985 to December 1986

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	29.0	2	1.800	0.500	0.300	0.080	0.070	0.100	0.040	0.020	0.020
Minimum	16.3	1	1.300	0.300	0.200 1/	0.020	0.020 1/	0.080 1/	0.010 1/	0.010 1/	0.010 1/
Average	23.2	2	1.570	0.390	0.230	0.040	0.020	0.060	0.020	0.010	0.010
Median	23.7	2	1.600	0.390	0.300	0.045	0.020	0.080 1/	0.020	0.010 1/	0.020
Analyses	4	4	4	4	3	4	4	4	4	4	3
< Limit 2/	0	0	0	0	1	0	1	2	1	2	1
Missing	0	0	0	0	1	0	0	0	0	0	1
						Spring					
Maximum	38.8	10	3.800	1.200	0.460	0.050	0.050	0.100	0.060	0.040	0.020
Minimum	12.9	2	1.500	0.400	0.360	0.020	0.020 1/	0.020 1/	0.010 1/	0.010 1/	0.010 1/
Average	29.1	4	2.460	0.570	0.400	0.030	0.030	0.040	0.020	0.020	0.010
Median	30.6	3	2.350	0.430	0.400	0.030	0.030	0.035	0.025	0.030	0.010 1/
Analyses	6	6	6	6	5	6	6	6	6	6	5
< Limit 2/	0	0	0	0	0	0	1	4	2	1	2
Missing	0	0	0	0	1	0	0	0	0	0	1
						Summer					
Maximum	20.8	7	3.900	0.960	0.900	0.087	0.087	0.200	0.040	0.040	0.010
Minimum	8.3	1	1.800	0.200	0.200	0.020	0.020 1/	0.100 1/	0.010 1/	0.010 1/	0.010 1/
Average	11.7	4	2.600	0.470	0.420	0.050	0.040	0.090	0.020	0.020	0.000
Median	10.5	3	2.400	0.325	0.320	0.055	0.030	0.100 1/	0.035	0.020	0.010 1/
Analyses	6	6	5	6	6	6	6	6	6	6	5
< Limit 2/	0	0	0	0	0	0	1	2	1	1	2
Missing	0	0	1	0	0	0	0	0	0	0	1
						Fall					
Maximum	31.1	5	3.400	0.440	0.440	0.120	0.030	0.050	0.030	0.020	0.010
Minimum	9.9	1	2.200	0.200	0.200	0.025	0.020	0.020 1/	0.010 1/	0.010 1/	0.010 1/
Average	17.2	3	2.630	0.360	0.340	0.060	0.020	0.030	0.010	0.010	0.000
Median	10.5	2	2.300	0.440	0.380	0.040	0.025	0.040	0.020	0.020	0.010 1/
Analyses	3	3	3	3	3	3	3	3	3	3	2
< Limit 2/	0	0	0	0	0	0	0	2	1	1	1
Missing	0	0	0	0	0	0	0	0	0	0	1

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Stony Creek near Dauphin, Pa., January 1985 to December 1986

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
						Winter					
Maximum	1,270	156	12.400	1.380	0.540	0.040	0.035	0.160	0.030	0.030	0.010
Minimum	120	5	2.100	0.320	0.260	0.020	0.020	0.080	0.020	0.010	0.010
Average	577	50	6.200	0.700	0.380	0.020	0.020	0.110	0.020	0.010	0.000
Median	470	30	6.300	0.570	0.370	0.020	0.020	0.110	0.030	0.020	0.010
Analyses	8	8	8	8	8	8	8	8	8	8	6
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	2
						Spring					
Maximum	373	191	17.000	1.700	1.000	0.120	0.100	0.240	0.110	0.050	0.010
Minimum	35.3	0	3.800	0.500	0.200	0.030	0.030	0.040 1/	0.020	0.010 1/	0.010 1/
Average	210	47	8.030	0.970	0.600	0.070	0.060	0.120	0.060	0.020	0.000
Median	219	27	7.400	0.980	0.600	0.070	0.070	0.120	0.070	0.030	0.010 1/
Analyses	17	17	16	17	17	17	17	17	17	17	17
< Limit 2/	0	0	0	0	0	0	0	6	0	6	6
Missing	0	0	1	0	0	0	0	0	0	0	0
						Summer					
Maximum	88.7	30	7.800	1.300	1.080	0.140	0.110	0.140	0.050	0.050	0.010
Minimum	19.5	3	3.400	0.420	0.360	0.030	0.030	0.020 1/	0.020	0.020	0.010
Average	57.9	16	6.290	0.860	0.660	0.050	0.040	0.050	0.030	0.030	0.010
Median	62.6	16	6.550	0.950	0.620	0.045	0.040	0.040	0.030	0.030	0.010
Analyses	14	14	14	14	14	14	14	14	14	14	3
< Limit 2/	0	0	0	0	0	0	0	7	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	11
						Fall					
Maximum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Minimum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Average	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Median	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Analyses	0	0	0	0	0	0	0	0	0	0	0
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, Stony Creek near Dauphin, Pa., January 1985 to December 1986

Seasonal combined flow nutrient statistics, Stony Creek near Dauphin, Pa., January 1985 to December 1986

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	1,270	156	12.400	1.380	0.540	0.080	0.070	0.160	0.040	0.030	0.020
Minimum	16.3	1	1.300	0.300	0.200 1/	0.020	0.020 1/	0.080 1/	0.010 1/	0.010 1/	0.010 1/
Average	392	34	4.650	0.600	0.340	0.020	0.020	0.090	0.020	0.010	0.010
Median	264	7	3.650	0.490	0.340	0.020	0.020 1/	0.090	0.030	0.015	0.010 1/
Analyses	12	12	12	12	11	12	12	12	12	12	9
< Limit 2/	0	0	0	0	1	0	1	2	1	2	1
Missing	0	0	0	0	1	0	0	0	0	0	3
Spring											
Maximum	373	191	17.000	1.700	1.000	0.120	0.100	0.240	0.110	0.050	0.020
Minimum	12.9	0	1.500	0.400	0.200	0.020	0.020	0.020 1/	0.010 1/	0.010 1/	0.010 1/
Average	163	36	6.510	0.860	0.550	0.050	0.050	0.100	0.050	0.020	0.000
Median	132	11	6.800	0.960	0.530	0.050	0.050	0.060	0.050	0.030	0.010 1/
Analyses	23	23	22	23	22	23	23	23	23	23	22
< Limit 2/	0	0	0	0	0	0	0	10	2	7	8
Missing	0	0	1	0	1	0	0	0	0	0	1
Summer											
Maximum	88.7	30	7.800	1.300	1.080	0.140	0.110	0.200	0.050	0.050	0.010
Minimum	8.3	1	1.800	0.200	0.200	0.020	0.020 1/	0.020 1/	0.010 1/	0.010 1/	0.010 1/
Average	44.1	12	5.320	0.750	0.590	0.050	0.040	0.060	0.030	0.020	0.000
Median	40.4	8	6.100	0.820	0.570	0.045	0.040	0.060	0.030	0.030	0.010 1/
Analyses	20	20	19	20	20	20	20	20	20	20	8
< Limit 2/	0	0	0	0	0	0	1	9	1	1	2
Missing	0	0	1	0	0	0	0	0	0	0	12
Fall											
Maximum	31.1	5	3.400	0.440	0.440	0.120	0.030	0.050	0.030	0.020	0.010
Minimum	9.9	1	2.200	0.200	0.200	0.025	0.020	0.020 1/	0.010 1/	0.010 1/	0.010 1/
Average	17.2	3	2.630	0.360	0.340	0.060	0.020	0.030	0.010	0.010	0.010
Median	10.5	2	2.300	0.440	0.380	0.040	0.025	0.040	0.020	0.020	0.010 1/
Analyses	3	3	3	3	3	3	3	3	3	3	2
< Limit 2/	0	0	0	0	0	0	0	2	1	1	1
Missing	0	0	0	0	0	0	0	0	0	0	1

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Stony Creek near Dauphin, Pa., January 1985 to December 1986

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
						Base Flow					
Maximum	38.8	10	3.900	1.200	0.900	0.120	0.087	0.200	0.060	0.040	0.020
Minimum	8.3	1	1.300	0.200	0.200 1/	0.020	0.020 1/	0.020 1/	0.010 1/	0.010 1/	0.010 1/
Average	20.5	13.3	2.300	0.470	0.370	0.040	0.030	0.060	0.020	0.010	0.010
Median	20.8	2	2.250	0.400	0.360	0.040	0.025	0.050	0.020	0.020	0.010 1/
Analyses	19	19	18	19	17	19	19	19	19	19	15
< Limit 2/	0	0	0	0	1	0	2	10	5	5	6
Missing	0	0	1	0	2	0	0	0	0	0	4
						Stormflow					
Maximum	1,270	191	17.100	1.700	1.080	0.140	0.110	0.240	0.110	0.050	0.010
Minimum	19.5	0	2.100	0.320	0.200	0.020	0.020	0.020 1/	0.020	0.010 1/	0.010 1/
Average	231	36	7.000	0.880	0.580	0.050	0.040	0.090	0.040	0.020	0.000
Median	120	18	6.650	0.960	0.560	0.050	0.040	0.080	0.040	0.030	0.010 1/
Analyses	39	39	38	39	39	39	39	39	39	39	26
< Limit 2/	0	0	0	0	0	0	0	13	0	6	6
Missing	0	0	1	0	0	0	0	0	0	0	13
						Combined Base Flow and Stormflow					
Maximum	1,270	191	17.000	1.700	1.080	0.140	0.110	0.240	0.110	0.050	0.020
Minimum	8.3	0	1.300	0.200	0.200 1/	0.020	0.020 1/	0.020 1/	0.010 1/	0.010 1/	0.010 1/
Average	162	26	5.500	0.740	0.510	0.050	0.040	0.080	0.030	0.020	0.000
Median	68.4	8	5.550	0.590	0.460	0.040	0.040	0.060	0.030	0.030	0.010 1/
Analyses	58	58	56	58	56	58	58	58	58	58	41
< Limit 2/	0	0	0	0	1	0	2	23	5	11	12
Missing	0	0	2	0	2	0	0	0	0	0	17

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Susquehanna River at Harrisburg, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	52,200	21	5.500	0.600	0.460	0.120	0.120	1.920	0.090	0.040	0.030
Minimum	17,000	3	1.600	0.200	0.160	0.020	0.020	1.000	0.020	0.010 1/	0.010 1/
Average	29,100	12	2.630	0.370	0.260	0.040	0.040	1.480	0.040	0.020	0.010
Median	25,600	12	2.200	0.375	0.225	0.040	0.035	1.460	0.045	0.020	0.010 1/
Analyses	12	11	11	12	10	11	12	12	12	12	9
< Limit 2/	0	0	0	0	0	0	0	0	0	3	2
Missing	0	1	1	0	2	1	0	0	0	0	3
Spring											
Maximum	48,400	26	5.800	1.400	1.400	0.070	0.070	1.500	0.100	0.060	0.020
Minimum	8,790	6	2.200	0.240	0.200	0.020 1/	0.020 1/	0.680	0.010 1/	0.010 1/	0.020 1/
Average	25,900	16	3.060	0.700	0.520	0.030	0.020	1.050	0.040	0.020	0.010
Median	23,000	13	2.800	0.760	0.465	0.030	0.030	1.100	0.050	0.020	0.020 1/
Analyses	13	13	13	13	12	13	13	12	13	13	12
< Limit 2/	0	0	0	0	0	2	2	0	1	2	1
Missing	0	0	0	0	1	0	0	1	0	0	1
Summer											
Maximum	28,900	27	11.000	1.440	1.100	0.300	0.300	1.500	0.160	0.100	0.080
Minimum	4,120	5	2.800	0.260	0.200	0.020 1/	0.020 1/	0.280	0.010 1/	0.010 1/	0.010 1/
Average	11,400	14	5.100	0.620	0.430	0.060	0.060	0.840	0.070	0.040	0.010
Median	7,860	13	4.250	0.550	0.400	0.043	0.040	1.000	0.070	0.040	0.010 1/
Analyses	14	14	14	14	13	14	13	14	14	14	8
< Limit 2/	0	0	0	0	0	1	1	0	1	1	2
Missing	0	0	0	0	1	0	1	0	0	0	6
Fall											
Maximum	38,200	40	5.900	0.980	0.600	0.070	0.070	1.660	0.140	0.060	0.020
Minimum	5,400	1	1.800	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.800	0.030	0.020	0.010
Average	19,400	11	3.080	0.390	0.290	0.030	0.030	1.260	0.040	0.020	0.010
Median	17,400	8	2.850	0.365	0.230	0.030	0.030	1.320	0.040	0.030	0.010
Analyses	14	13	14	14	14	14	14	14	14	13	10
< Limit 2/	0	0	0	1	2	2	2	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	1	4

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Susquehanna River at Harrisburg, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
					Winter						
Maximum	349,000	489	6.900	2.920	2.760	0.180	0.180	2.420	0.360	0.050	0.020
Minimum	27,300	6	1.700	0.240	0.150	0.020	0.020	1.040	0.030	0.010 1/	0.010
Average	100,000	108	3.680	0.850	0.550	0.060	0.060	1.590	0.110	0.020	0.010
Median	69,900	55	3.300	0.740	0.460	0.065	0.060	1.620	0.075	0.030	0.010
Analyses 2/	30	28	30	30	29	30	30	29	30	30	17
< Limit	0	0	0	0	0	0	0	0	0	1	0
Missing	0	2	0	0	1	0	0	1	0	0	13
					Spring						
Maximum	216,000	397	6.900	2.670	1.410	0.220	0.220	1.630	0.330	0.140	0.020
Minimum	15,900	9	1.900	0.200	0.150	0.020 1/	0.020 1/	0.300	0.040	0.020	0.010
Average	110,000	97	3.710	0.780	0.430	0.050	0.050	1.070	0.120	0.030	0.010
Median	112,000	75	3.450	0.675	0.400	0.040	0.040	1.110	0.120	0.030	0.010
Analyses 2/	70	67	70	70	70	69	69	70	70	70	19
< Limit	0	0	0	0	0	8	8	0	0	0	0
Missing	0	3	0	0	0	1	1	0	0	0	51
					Summer						
Maximum	55,400	148	5.500	1.360	0.680	0.100	0.100	1.760	0.200	0.060	0.010
Minimum	7,320	11	1.600	0.310	0.200 1/	0.020 1/	0.020 1/	0.720	0.020	0.020	0.010
Average	21,900	41	3.030	0.800	0.390	0.040	0.040	1.220	0.090	0.030	0.000
Median	17,600	25	2.650	0.795	0.390	0.048	0.043	1.170	0.085	0.030	0.010
Analyses 2/	14	14	14	14	14	14	14	14	14	14	10
< Limit	0	0	0	0	1	3	3	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	4
					Fall						
Maximum	83,700	177	5.500	2.300	0.850	0.075	0.060	2.220	0.150	0.040	0.010
Minimum	27,000	15	1.600	0.260	0.160	0.020 1/	0.020 1/	1.400	0.060	0.030	0.010
Average	58,800	64	3.580	0.920	0.420	0.030	0.030	1.740	0.080	0.030	0.000
Median	62,000	49	3.850	0.860	0.415	0.040	0.040	1.770	0.080	0.030	0.010
Analyses 2/	10	10	10	10	10	10	10	10	10	10	6
< Limit	0	0	0	0	0	4	4	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	4

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, Susquehanna River at Harrisburg, Pa., January 1985 to December 1989

Seasonal combined flow nutrient statistics, Susquehanna River at Harrisburg, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	349,000	489	6.900	2.920	2.760	0.180	0.180	2.420	0.360	0.050	0.030
Minimum	17,000	3	1.600	0.200	0.150	0.020	0.020	1.000	0.020	0.010 1/	0.010 1/
Average	79,700	81	3.400	0.710	0.470	0.060	0.050	1.560	0.090	0.020	0.010 1/
Median	50,400	32	3.200	0.675	0.440	0.060	0.050	1.620	0.065	0.025	0.010
Analyses	42	39	41	42	39	41	42	41	42	42	26
< Limit 2/	0	0	0	0	0	0	0	0	0	4	2
Missing	0	3	1	0	3	1	0	1	0	0	16
						Spring					
Maximum	216,000	397	6.900	2.670	1.410	0.220	0.220	1.630	0.330	0.140	0.020
Minimum	8,790	6	1.900	0.200	0.150	0.020 1/	0.020 1/	0.300	0.010 1/	0.010 1/	0.020 1/
Average	96,500	83	3.610	0.770	0.440	0.050	0.050	1.070	0.110	0.030	0.010 1/
Median	87,100	63	3.300	0.690	0.405	0.040	0.040	1.100	0.100	0.030	0.020
Analyses	83	80	83	83	82	82	82	82	83	83	31
< Limit 2/	0	0	0	0	0	10	10	0	1	2	1
Missing	0	3	0	0	1	1	1	1	0	0	52
						Summer					
Maximum	55,400	148	11.000	1.440	1.100	0.300	0.300	1.760	0.200	0.100	0.080
Minimum	4,120	5	1.600	0.260	0.200 1/	0.020 1/	0.020 1/	0.280	0.010 1/	0.010 1/	0.010 1/
Average	16,600	27	4.070	0.710	0.410	0.050	0.050	1.030	0.080	0.030	0.010 1/
Median	13,700	22	3.500	0.700	0.400	0.045	0.040	1.040	0.070	0.030	0.010
Analyses	28	28	28	28	27	28	27	28	28	28	18
< Limit 2/	0	0	0	0	1	4	4	0	1	1	2
Missing	0	0	0	0	1	0	1	0	0	0	10
						Fall					
Maximum	83,700	177	5.900	2.300	0.850	0.075	0.070	2.220	0.150	0.060	0.020
Minimum	5,440	1	1.600	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.800	0.030	0.020	0.010
Average	35,800	34	3.290	0.610	0.340	0.030	0.030	1.460	0.060	0.030	0.010
Median	29,100	16	3.050	0.480	0.310	0.033	0.033	1.440	0.060	0.030	0.010
Analyses	24	23	24	24	24	24	24	24	24	23	16
< Limit 2/	0	0	0	1	2	6	6	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	1	8

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Susquehanna River at Harrisburg, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Base Flow					
Maximum	52,200	40	11.000	1.440	1.400	0.300	0.300	1.920	0.160	0.100	0.080
Minimum	4,120	1	1.600	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.280	0.010 1/	0.010 1/	0.010 1/
Average	21,100	13	3.520	0.520	0.380	0.040	0.040	1.150	0.050	0.030	0.010
Median	18,800	12	3.050	0.500	0.300	0.035	0.030	1.130	0.050	0.030	0.010 1/
Analyses	53	51	52	53	49	52	52	52	53	52	39
< Limit 2/	0	0	0	1	2	5	5	0	2	6	5
Missing	0	2	1	0	4	1	1	1	0	1	14
						Stormflow					
Maximum	349,000	489	6.900	2.920	2.760	0.220	0.220	2.420	0.360	0.140	0.020
Minimum	7,320	6	1.600	0.200	0.200 1/	0.020 1/	0.020 1/	0.300	0.020	0.010 1/	0.010
Average	93,300	90	3.620	0.810	0.450	0.050	0.050	1.260	0.110	0.030	0.010
Median	75,300	62	3.350	0.740	0.410	0.050	0.040	1.190	0.100	0.030	0.010
Analyses	124	119	124	124	123	123	123	123	124	124	52
< Limit 2/	0	0	0	0	1	15	15	0	0	1	0
Missing	0	5	0	0	1	1	1	1	0	0	72
						Combined Base Flow and Stormflow					
Maximum	349,000	489	11.000	2.920	2.760	0.300	0.300	2.420	0.360	0.140	0.080
Minimum	4,120	1	1.600	0.200 1/	0.200 1/	0.020 1/	0.020 1/	0.280	0.010 1/	0.010 1/	0.010 1/
Average	71,700	67	3.590	0.720	0.430	0.050	0.050	1.230	0.090	0.030	0.010
Median	48,400	37	3.300	0.660	0.400	0.040	0.040	1.180	0.080	0.030	0.010
Analyses	177	170	176	177	172	175	175	175	177	176	91
< Limit 2/	0	0	0	1	3	20	20	0	2	7	5
Missing	0	7	1	0	5	2	2	2	0	1	86

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Paxton Creek near Penbrook, Pa., January 1985 to December 1986

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	23.0	10	10.300	0.800	0.460	0.045	0.060	1.400	0.040	0.070	0.040
Minimum	4.1	1	2.000	0.160	0.140	0.020 1/	0.020 1/	0.820	0.010 1/	0.010 1/	0.010
Average	12.6	6	4.570	0.420	0.310	0.020	0.020	1.150	0.020	0.020	0.010
Median	12.3	6	2.850	0.450	0.380	0.020 1/	0.020 1/	1.160	0.030	0.020	0.010
Analyses	12	12	12	11	11	11	12	11	11	12	8
< Limit 2/	0	0	0	0	0	6	6	0	2	2	0
Missing	0	0	0	1	1	1	0	1	1	0	4
						Spring					
Maximum	9.8	28	9.900	1.960	0.930	0.100	0.100	1.200	0.150	0.060	0.020
Minimum	0.9	3	2.100	0.200	0.200	0.020 1/	0.020 1/	0.400	0.010 1/	0.010 1/	0.010 1/
Average	6.0	10	3.870	0.680	0.480	0.030	0.030	0.790	0.040	0.020	0.010
Median	6.6	6	3.100	0.560	0.500	0.030	0.025	0.760	0.050	0.020	0.010 1/
Analyses	13	13	13	13	12	13	12	13	13	13	10
< Limit 2/	0	0	0	0	0	1	2	0	2	3	2
Missing	0	0	0	0	1	0	1	0	0	0	3
						Summer					
Maximum	2.6	38	10.400	0.620	0.550	0.390	0.390	1.120	0.140	0.360	0.360
Minimum	0.7	1	2.400	0.200	0.200	0.025	0.020 1/	0.500	0.010 1/	0.010 1/	0.010 1/
Average	1.6	14	5.090	0.440	0.370	0.070	0.070	0.730	0.050	0.070	0.060
Median	1.7	11	3.350	0.480	0.400	0.040	0.038	0.630	0.045	0.030	0.030
Analyses	10	10	10	10	10	10	10	10	10	10	8
< Limit 2/	0	0	0	0	0	0	1	0	1	1	1
Missing	0	0	0	0	0	0	0	0	0	0	2
						Fall					
Maximum	19.0	29	12.800	0.620	0.550	0.070	0.070	1.300	0.090	0.060	0.030
Minimum	1.9	1	2.100	0.200	0.200 1/	0.020 1/	0.020 1/	0.300	0.020	0.020 1/	0.010
Average	7.5	12	5.650	0.360	0.300	0.020	0.020	0.840	0.040	0.020	0.010
Median	4.3	10	5.700	0.360	0.300	0.025	0.020	0.900	0.030	0.020 1/	0.010
Analyses	11	11	11	11	11	11	11	11	11	11	9
< Limit 2/	0	0	0	0	1	1	2	0	0	2	0
Missing	0	0	0	0	0	0	0	0	0	0	2

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Paxton Creek near Penbrook, Pa., January 1985 to December 1988

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	1,330	3,120	16.000	3.900	1.640	0.180	0.135	1.840	0.370	0.040	0.020
Minimum	30.0	17	2.600	0.260	0.180	0.020	0.020 1/	0.720	0.020	0.010	0.010
Average	186	436	7.580	1.000	0.520	0.070	0.040	1.150	0.160	0.020	0.010
Median	113	190	6.500	0.700	0.450	0.070	0.040	1.040	0.160	0.030	0.010
Analyses 2/	45	37	45	45	45	45	45	45	45	45	36
< Limit	0	0	0	0	0	0	1	0	0	0	0
Missing	0	8	0	0	0	0	0	0	0	0	9
						Spring					
Maximum	1,050	13,283	67.000	3.200	1.360	0.340	0.200	1.220	0.820	0.090	0.040
Minimum	16.0	11	3.100	0.200	0.200 1/	0.020 1/	0.020 1/	0.100 1/	0.040	0.010 1/	0.010 1/
Average	160	1,947	15.010	1.350	0.610	0.080	0.050	0.740	0.210	0.030	0.010
Median	59.5	299	15.000	1.280	0.550	0.057	0.040	0.730	0.130	0.030	0.010 1/
Analyses 2/	36	36	35	36	36	36	36	36	36	36	28
< Limit	0	0	0	0	2	2	3	1	0	3	6
Missing	0	0	1	0	0	0	0	0	0	0	8
						Summer					
Maximum	3,550	2,090	22.000	3.800	1.400	1.020	0.360	2.640	0.910	0.130	0.090
Minimum	1.5	26	3.800	0.380	0.200	0.020	0.020	0.100 1/	0.060	0.020	0.010
Average	288	525	8.510	1.430	0.640	0.120	0.060	1.050	0.260	0.050	0.020
Median	59.0	398	7.650	1.290	0.630	0.080	0.060	0.980	0.210	0.050	0.030
Analyses 2/	60	60	60	60	60	60	60	60	60	60	60
< Limit	0	0	0	0	0	0	0	1	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
						Fall					
Maximum	899	922	11.500	3.920	1.800	0.840	0.840	1.800	1.000	0.530	0.530
Minimum	8.8	6	1.100	0.250	0.190	0.020	0.020	0.260	0.050	0.020	0.010
Average	162	218	6.450	1.290	0.540	0.090	0.070	0.760	0.260	0.080	0.040
Median	31.0	92	7.100	0.900	0.500	0.055	0.035	0.640	0.210	0.060	0.020
Analyses 2/	30	30	29	29	29	30	29	30	30	29	29
< Limit	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	1	1	1	0	1	0	0	1	1

1/ analytical detection limit

2/

Seasonal combined flow nutrient statistics, Paxton Creek near Penbrook, Pa., January 1985 to December 1986

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
					Winter						
Maximum	1,330	3,120	16.000	3.900	1.640	0.180	0.135	1.840	0.370	0.070	0.040
Minimum	4.1	1	2.000	0.160	0.140	0.020 1/	0.020 1/	0.720	0.010 1/	0.010 1/	0.010
Average	150	331	6.940	0.890	0.480	0.060	0.030	1.150	0.130	0.020	0.010
Median	94.0	155	5.900	0.650	0.400	0.060	0.035	1.050	0.125	0.030	0.010
Analyses	57	49	57	56	56	56	57	56	56	57	44
< Limit 2/	0	0	0	0	0	6	7	0	2	2	0
Missing	0	8	0	1	1	1	0	1	1	0	13
					Spring						
Maximum	1,050	13,283	67.000	3.200	1.360	0.340	0.200	1.220	0.820	0.090	0.040
Minimum	0.9	3	2.100	0.200	0.200 1/	0.020 1/	0.020 1/	0.100 1/	0.010 1/	0.010 1/	0.010 1/
Average	119	1,433	11.990	1.170	0.580	0.070	0.040	0.750	0.170	0.030	0.010
Median	37.0	97	6.750	1.100	0.500	0.040	0.035	0.740	0.100	0.030	0.010 1/
Analyses	49	49	48	49	48	49	48	49	49	49	38
< Limit 2/	0	0	0	0	2	3	5	1	2	6	8
Missing	0	0	1	0	1	0	1	0	0	0	11
					Summer						
Maximum	3,550	2,090	22.000	3.800	1.400	1.020	0.390	2.640	0.910	0.360	0.360
Minimum	0.7	1	2.400	0.200	0.200	0.020	0.020 1/	0.100 1/	0.010 1/	0.010 1/	0.010 1/
Average	247	452	8.020	1.290	0.610	0.110	0.060	1.000	0.230	0.050	0.030
Median	49.0	311	7.150	1.165	0.590	0.078	0.057	0.940	0.190	0.050	0.030
Analyses	70	70	70	70	70	70	70	70	70	70	68
< Limit 2/	0	0	0	0	0	0	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0	0	2
					Fall						
Maximum	899	922	12.800	3.920	1.800	0.840	0.840	1.800	1.000	0.530	0.530
Minimum	1.9	1	1.100	0.200	0.200 1/	0.020 1/	0.020 1/	0.260	0.020	0.020 1/	0.010
Average	120	163	6.230	1.040	0.470	0.070	0.050	0.780	0.200	0.060	0.030
Median	20.0	39	6.600	0.765	0.430	0.040	0.030	0.640	0.140	0.050	0.020
Analyses	41	41	40	40	40	41	40	41	41	40	38
< Limit 2/	0	0	0	0	1	1	2	0	0	2	0
Missing	0	0	1	1	1	0	1	0	0	1	3

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Paxton Creek near Penbrook, Pa., January 1985 to December 1988

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
					Base Flow						
Maximum	23.0	38	12.800	1.960	0.930	0.390	0.390	1.400	0.150	0.360	0.360
Minimum	0.7	1	2.000	0.160	0.200 1/	0.020 1/	0.020 1/	0.300	0.010 1/	0.010 1/	0.010 1/
Average	7.1	10	4.740	0.480	0.370	0.030	0.030	0.880	0.040	0.030	0.020
Median	5.5	7	3.400	0.460	0.390	0.030	0.025	0.900	0.040	0.020	0.010 1/
Analyses	46	46	46	45	44	45	45	45	45	46	35
< Limit 2/	0	0	0	0	1	8	11	0	5	8	3
Missing	0	0	0	1	2	1	1	1	1	0	11
					Stormflow						
Maximum	3,550	13,283	67.000	3.920	1.800	1.020	0.840	2.640	1.000	0.530	0.530
Minimum	1.5	6	1.100	0.200	0.200 1/	0.020 1/	0.020 1/	0.100 1/	0.020	0.010 1/	0.010 1/
Average	212	762	9.250	1.280	0.590	0.090	0.050	0.960	0.220	0.040	0.020
Median	75.0	260	7.400	1.100	0.540	0.070	0.040	0.900	0.170	0.040	0.020
Analyses	171	163	169	170	170	171	170	171	171	170	153
< Limit 2/	0	0	0	0	2	2	4	2	0	3	6
Missing	0	8	2	1	1	0	1	0	0	1	18
					Combined Base Flow and Stormflow						
Maximum	3,550	13,283	67.000	3.920	1.800	1.020	0.840	2.640	1.000	0.530	0.530
Minimum	0.7	1	1.100	0.160	0.200 1/	0.020 1/	0.020 1/	0.100 1/	0.010 1/	0.010 1/	0.010 1/
Average	169	597	8.290	1.110	0.540	0.080	0.050	0.940	0.180	0.040	0.020
Median	49.9	147	6.700	0.900	0.500	0.060	0.040	0.900	0.140	0.040	0.020
Analyses	217	209	215	215	214	216	215	216	216	216	188
< Limit 2/	0	0	0	0	3	10	15	2	5	11	9
Missing	0	8	2	2	3	1	2	1	1	1	29

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Swatara Creek near Hershey, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	1,080	22	7.100	0.920	0.900	0.190	0.190	13.000	0.180	0.070	0.050
Minimum	80.0	1	1.800	0.200	0.200	0.035	0.035	2.700	0.020 1/	0.020 1/	0.010
Average	532	9	3.080	0.480	0.390	0.090	0.090	4.350	0.050	0.030	0.020
Median	478	7	2.300	0.460	0.300	0.093	0.093	3.795	0.050	0.035	0.020
Analyses 2/	14	14	14	14	13	14	14	14	14	14	11
< Limit	0	0	0	0	0	0	0	0	1	1	0
Missing	0	0	0	0	1	0	0	0	0	0	3
						Spring					
Maximum	1,400	30	6.800	3.690	2.870	0.200	0.200	7.260	0.120	0.090	0.040
Minimum	132	5	1.600	0.200	0.200	0.020 1/	0.020 1/	2.100	0.020	0.010 1/	0.020 1/
Average	466	15	3.020	0.970	0.710	0.040	0.040	3.470	0.060	0.030	0.020
Median	355	14	2.600	0.575	0.490	0.045	0.030	3.060	0.060	0.035	0.020 1/
Analyses 2/	14	14	14	14	13	14	14	14	14	14	10
< Limit	0	0	0	0	0	1	1	0	0	2	1
Missing	0	0	0	0	1	0	0	0	0	0	4
						Summer					
Maximum	1,040	20	9.600	1.680	1.680	0.210	0.200	5.720	0.170	0.140	0.090
Minimum	80.0	5	2.300	0.230	0.200	0.030	0.020 1/	3.100	0.010 1/	0.010 1/	0.010
Average	260	13	4.590	0.760	0.550	0.060	0.060	4.180	0.080	0.050	0.030
Median	184	11	3.050	0.600	0.400	0.050	0.050	4.100	0.090	0.050	0.030
Analyses 2/	13	13	12	13	13	13	13	13	13	13	11
< Limit	0	0	0	0	0	0	1	0	1	1	0
Missing	0	0	1	0	0	0	0	0	0	0	2
						Fall					
Maximum	1,070	21	7.700	1.010	0.860	0.100	0.100	5.000	0.120	0.090	0.040
Minimum	125	1	1.600	0.200	0.200	0.020	0.020	2.640	0.040	0.030	0.010
Average	443	10	3.710	0.490	0.410	0.040	0.040	3.810	0.060	0.040	0.020
Median	298	9	3.000	0.445	0.405	0.040	0.030	3.960	0.060	0.035	0.020
Analyses 2/	14	14	14	14	14	14	14	14	14	14	13
< Limit	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	1

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Swatara Creek near Hershey, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
					Winter						
Maximum	5,514	667	10.700	4.000	1.800	1.140	1.110	4.320	0.480	0.220	0.180
Minimum	428	8	1.400	0.200	0.200	0.020	0.020	2.160	0.030	0.020 1/	0.010
Average	2,650	215	5.470	1.160	0.690	0.220	0.210	2.990	0.180	0.060	0.030
Median	2,270	160	5.500	0.900	0.610	0.230	0.210	2.760	0.140	0.050	0.020
Analyses	37	37	37	37	37	37	37	37	37	37	28
< Limit 2/	0	0	0	0	0	0	0	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	9
					Spring						
Maximum	10,700	720	19.800	3.480	1.200	0.290	0.230	3.700	0.750	0.110	0.040
Minimum	501	5	2.000	0.290	0.200	0.020	0.020	1.320	0.050	0.030	0.010
Average	3,080	173	6.630	1.040	0.550	0.100	0.080	2.410	0.160	0.050	0.010
Median	2,160	70	5.400	0.855	0.520	0.095	0.080	2.520	0.120	0.050	0.010
Analyses	52	52	51	52	52	52	52	52	52	52	31
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	1	0	0	0	0	0	0	0	21
					Summer						
Maximum	5,460	963	19.000	4.300	2.060	0.470	0.470	4.400	0.920	0.250	0.070
Minimum	110	8	3.200	0.330	0.250	0.050	0.050	1.480	0.030	0.030	0.010
Average	1,800	219	6.820	1.490	0.810	0.140	0.130	2.640	0.270	0.060	0.020
Median	1,475	146	5.500	1.200	0.800	0.115	0.110	2.380	0.270	0.060	0.030
Analyses	37	37	37	37	37	37	37	37	37	37	36
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	1
					Fall						
Maximum	5,780	616	9.100	3.700	1.200	0.210	0.210	4.840	0.320	0.230	0.120
Minimum	490	8	1.000 1/	0.440	0.200	0.020	0.020	1.740	0.060	0.020	0.010
Average	2,300	157	4.330	1.130	0.650	0.100	0.090	3.050	0.140	0.060	0.020
Median	1,650	62	4.100	0.910	0.660	0.100	0.100	3.080	0.120	0.060	0.020
Analyses	29	29	29	29	29	29	29	29	29	29	26
< Limit 2/	0	0	2	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	3

1/ analytical detection limit

2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, Swatara Creek near Hershey, Pa., January 198 to December 198

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	5,514	667	10.700	4.000	1.800	1.140	1.110	13.000	0.480	0.220	0.180
Minimum	80.0	1	1.400	0.200	0.200	0.020	0.020	2.160	0.020 1/	0.020 1/	0.010
Average	2,070	158	4.820	0.970	0.610	0.190	0.180	3.370	0.150	0.050	0.020
Median	1,540	49	4.800	0.720	0.530	0.160	0.155	3.240	0.100	0.050	0.020
Analyses	51	51	51	51	50	51	51	51	51	51	39
< Limit 2/	0	0	0	0	0	0	0	0	1	2	0
Missing	0	0	0	0	1	0	0	0	0	0	12
						Spring					
Maximum	10,700	720	19.800	3.690	2.870	0.290	0.230	7.260	0.750	0.110	0.040
Minimum	132	5	1.600	0.200	0.200	0.020 1/	0.020 1/	1.320	0.020	0.010 1/	0.020 1/
Average	2,530	139	5.850	1.020	0.590	0.090	0.070	2.630	0.140	0.040	0.010
Median	1,490	50	5.000	0.750	0.500	0.075	0.067	2.640	0.110	0.050	0.020 1/
Analyses	66	66	65	66	65	66	66	66	66	66	41
< Limit 2/	0	0	0	0	0	1	1	0	0	2	1
Missing	0	0	1	0	1	0	0	0	0	0	25
						Summer					
Maximum	5,460	963	19.000	4.300	2.060	0.470	0.470	5.720	0.920	0.250	0.090
Minimum	80.0	5	2.300	0.230	0.200	0.030	0.020 1/	1.480	0.010 1/	0.010 1/	0.010
Average	1,410	165	6.270	1.300	0.740	0.120	0.110	3.040	0.220	0.060	0.020
Median	1,060	41	5.500	1.100	0.700	0.090	0.090	2.940	0.150	0.060	0.030
Analyses	50	50	49	50	50	50	50	50	50	50	47
< Limit 2/	0	0	0	0	0	0	1	0	1	1	0
Missing	0	0	1	0	0	0	0	0	0	0	3
						Fall					
Maximum	5,780	616	9.100	3.700	1.200	0.210	0.210	5.000	0.320	0.230	0.120
Minimum	125	1	1.000 1/	0.200	0.200	0.020	0.020	1.740	0.040	0.020	0.010
Average	1,690	109	4.130	0.920	0.570	0.080	0.070	3.300	0.110	0.050	0.020
Median	1,080	29	4.000	0.760	0.550	0.080	0.070	3.300	0.090	0.050	0.020
Analyses	43	43	43	43	43	43	43	43	43	43	39
< Limit 2/	0	0	2	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	4

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Swatara Creek near Hershey, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Base Flow					
Maximum	1,400	30	9.600	3.690	2.870	0.210	0.200	13.000	0.180	0.140	0.090
Minimum	80.0	1	1.600	0.200	0.200	0.020 1/	0.020 1/	2.100	0.010 1/	0.010 1/	0.020 1/
Average	428	12	3.560	0.670	0.510	0.060	0.060	3.950	0.060	0.040	0.020
Median	337	11	2.750	0.520	0.420	0.050	0.045	3.750	0.060	0.040	0.020 1/
Analyses	55	55	54	55	53	55	55	55	55	55	45
< Limit 2/	0	0	0	0	0	1	2	0	2	4	1
Missing	0	0	1	0	2	0	0	0	0	0	10
						Stormflow					
Maximum	10,700	963	19.800	4.300	2.060	1.140	1.110	4.840	0.920	0.250	0.180
Minimum	110	5	1.000 1/	0.200	0.200	0.020	0.020	1.320	0.030	0.020 1/	0.010
Average	2,528	191	5.960	1.190	0.660	0.140	0.130	2.720	0.190	0.050	0.020
Median	1,900	106	5.300	0.960	0.620	0.110	0.100	2.640	0.130	0.050	0.020
Analyses	155	155	154	155	155	155	155	155	155	155	121
< Limit 2/	0	0	2	0	0	0	0	0	0	1	0
Missing	0	0	1	0	0	0	0	0	0	0	34
						Combined Base Flow and Stormflow					
Maximum	10,700	963	19.800	4.300	2.870	1.140	1.110	13.000	0.920	0.250	0.180
Minimum	80.0	1	1.000 1/	0.200	0.200	0.020 1/	0.020 1/	1.320	0.010 1/	0.010 1/	0.020 1/
Average	1,980	144	5.340	1.060	0.630	0.120	0.110	3.040	0.160	0.050	0.020
Median	1,400	45	4.800	0.850	0.560	0.093	0.090	2.880	0.100	0.050	0.020 1/
Analyses	210	210	208	210	208	210	210	210	210	210	166
< Limit 2/	0	0	2	0	0	1	2	0	2	5	1
Missing	0	0	2	0	2	0	0	0	0	0	44

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, West Conewago Creek near Manchester, Pa., January

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
					Winter						
Maximum	1,600	17	6.000	0.940	0.800	0.240	0.210	4.680	0.150	0.140	0.130
Minimum	60.0	1	2.000	0.200	0.200	0.020 1/	0.020 1/	1.700	0.050	0.040	0.010
Average	478	6	3.970	0.520	0.420	0.050	0.050	3.480	0.090	0.070	0.060
Median	370	6	3.700	0.550	0.420	0.040	0.035	3.480	0.100	0.070	0.060
Analyses	15	15	15	15	14	15	15	15	15	15	15
< Limit 2/	0	0	0	0	0	2	2	0	0	0	0
Missing	0	0	0	0	1	0	0	0	0	0	0
					Spring						
Maximum	806	36	9.100	1.960	1.860	0.140	0.140	4.220	0.290	0.250	0.200
Minimum	46.0	11	2.800	0.070	0.070	0.020 1/	0.020 1/	0.460	0.080	0.040	0.010
Average	276	19	4.620	0.790	0.650	0.040	0.030	1.630	0.140	0.090	0.060
Median	286	16	4.050	0.730	0.520	0.033	0.030	1.390	0.130	0.080	0.055
Analyses	14	14	14	14	14	14	14	14	14	14	14
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
					Summer						
Maximum	180	92	9.900	1.600	0.970	0.080	0.080	1.800	0.350	0.260	0.220
Minimum	26.0	16	3.900	0.390	0.200	0.020 1/	0.020 1/	0.040	0.010 1/	0.010 1/	0.010 1/
Average	74.2	34	6.650	0.820	0.500	0.040	0.030	0.780	0.230	0.140	0.080
Median	66.5	27	6.450	0.755	0.400	0.040	0.040	0.610	0.235	0.145	0.080
Analyses	12	12	12	12	11	12	11	12	12	12	12
< Limit 2/	0	0	0	0	0	1	1	0	1	1	1
Missing	0	0	0	0	1	0	1	0	0	0	0
					Fall						
Maximum	906	44	8.500	1.020	1.020	0.090	0.085	3.520	0.300	0.220	0.140
Minimum	47.0	1	2.900	0.220	0.200 1/	0.020 1/	0.020 1/	0.520	0.040	0.040	0.010
Average	290	13	5.120	0.580	0.510	0.030	0.030	2.010	0.140	0.100	0.070
Median	164	9	4.950	0.600	0.490	0.040	0.035	1.860	0.120	0.095	0.070
Analyses	14	13	14	14	14	14	14	14	14	14	14
< Limit 2/	0	0	0	0	1	3	3	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, West Conewago Creek near Manchester, Pa., January 1985 to December 1989

Statistic	Flow cfs	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
		mg/l									
						Winter					
Maximum	8,680	422	11.700	7.400	2.200	0.580	0.560	5.060	0.530	0.280	0.160
Minimum	340	7	2.500	0.270	0.200	0.025	0.025	1.200	0.060	0.020	0.020
Average	2,960	156	6.910	1.270	0.820	0.180	0.170	3.020	0.230	0.120	0.060
Median	1,820	130	6.600	1.130	0.930	0.160	0.155	3.000	0.240	0.130	0.060
Analyses	53	52	53	53	53	53	53	53	53	53	53
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0
						Spring					
Maximum	13,800	866	21.900	4.310	1.610	1.190	0.430	3.040	0.730	0.280	0.210
Minimum	284	14	3.800	0.350	0.260	0.020 1/	0.020 1/	1.120	0.080	0.010	0.010
Average	2,700	158	9.410	1.300	0.770	0.140	0.110	1.990	0.260	0.130	0.080
Median	1,900	94	8.400	1.020	0.680	0.080	0.070	1.940	0.260	0.140	0.080
Analyses	71	70	71	71	71	71	71	71	71	71	71
< Limit 2/	0	0	0	0	0	2	2	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0
						Summer					
Maximum	3,850	1,120	15.000	4.600	1.720	0.720	0.610	3.740	1.500	0.780	0.670
Minimum	43	11	3.400	0.290	0.200	0.020	0.020	0.380	0.140	0.080	0.010
Average	958	234	7.690	1.320	0.770	0.170	0.150	1.510	0.470	0.260	0.190
Median	600	124	7.400	1.100	0.700	0.105	0.100	1.200	0.420	0.250	0.180
Analyses	37	37	37	37	37	37	37	37	37	37	37
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
						Fall					
Maximum	9,400	1,133	17.000	4.100	1.900	0.265	0.245	4.400	1.430	0.410	0.320
Minimum	229	11	3.500	0.490	0.380	0.020 1/	0.020 1/	1.000	0.130	0.080	0.030
Average	2,090	272	7.480	1.600	0.940	0.100	0.090	2.570	0.480	0.210	0.150
Median	1,280	130	6.850	1.380	0.830	0.100	0.080	2.640	0.395	0.215	0.150
Analyses	26	26	26	26	26	26	26	26	26	26	26
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, West Conewago Creek near Manchester, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	8,680	422	11.700	7.400	2.200	0.580	0.560	5.060	0.530	0.280	0.160
Minimum	60.0	1	2.000	0.200	0.200	0.020 1/	0.020 1/	1.200	0.050	0.020	0.010
Average	2,410	122	6.260	1.100	0.740	0.150	0.140	3.120	0.200	0.110	0.060
Median	1,280	45	6.200	0.970	0.730	0.143	0.130	3.040	0.180	0.115	0.060
Analyses	68	67	68	68	67	68	68	68	68	68	68
< Limit 2/	0	0	0	0	0	2	2	0	0	0	0
Missing	0	1	0	0	1	0	0	0	0	0	0
						Spring					
Maximum	13,800	866	21.900	4.310	1.860	1.190	0.430	4.220	0.730	0.280	0.210
Minimum	46.0	11	2.800	0.070	0.070	0.020 1/	0.020 1/	0.460	0.080	0.010	0.010
Average	2,300	135	8.620	1.220	0.750	0.120	0.090	1.930	0.240	0.130	0.070
Median	1,670	72	8.000	0.960	0.650	0.070	0.060	1.860	0.220	0.140	0.080
Analyses	85	84	85	85	85	85	85	85	85	85	85
< Limit 2/	0	0	0	0	0	3	3	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0
						Summer					
Maximum	3,850	1,120	15.000	4.600	1.720	0.720	0.610	3.740	1.500	0.780	0.670
Minimum	26.0	11	3.400	0.290	0.200	0.020 1/	0.020 1/	0.040	0.010 1/	0.010 1/	0.010 1/
Average	741	185	7.430	1.190	0.710	0.130	0.120	1.330	0.410	0.230	0.160
Median	355	81	7.300	1.040	0.700	0.080	0.080	1.000	0.360	0.220	0.150
Analyses	49	49	49	49	48	49	48	49	49	49	49
< Limit 2/	0	0	0	0	0	1	1	0	1	1	1
Missing	0	0	0	0	1	0	1	0	0	0	0
						Fall					
Maximum	9,400	1,133	17.000	4.100	1.900	0.265	0.245	4.400	1.430	0.410	0.320
Minimum	47.0	1	2.900	0.220	0.200 1/	0.020 1/	0.020 1/	0.520	0.040	0.040	0.010
Average	1,460	186	6.660	1.240	0.790	0.080	0.070	2.370	0.360	0.180	0.120
Median	650	44	6.100	1.115	0.770	0.055	0.050	2.220	0.260	0.180	0.110
Analyses	40	39	40	40	40	40	40	40	40	40	40
< Limit 2/	0	0	0	0	1	4	4	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, West Conewago Creek near Manchester, Pa., January 1985 to December 1989

Statistic	Flow cfs	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
		mg/l									
					Base Flow						
Maximum	1,600	92	9.900	1.960	1.860	0.240	0.210	4.680	0.350	0.260	0.220
Minimum	26.0	1	2.000	0.070	0.140 1/	0.020 1/	0.020 1/	0.040	0.010 1/	0.010 1/	0.010 1/
Average	290	17	5.010	0.670	0.520	0.040	0.040	2.040	0.140	0.100	0.070
Median	191	14	4.700	0.600	0.500	0.040	0.030	1.800	0.130	0.090	0.060
Analyses	55	54	55	55	53	55	54	55	55	55	55
< Limit 2/	0	0	0	0	1	7	7	0	1	1	1
Missing	0	1	0	0	2	0	1	0	0	0	0
					Stormflow						
Maximum	13,800	1,133	21.900	7.400	2.200	1.190	0.610	5.060	1.500	0.780	0.670
Minimum	43.0	7	2.500	0.270	0.200	0.020 1/	0.020 1/	0.380	0.060	0.010	0.010
Average	2,340	189	8.090	1.340	0.810	0.150	0.130	2.270	0.330	0.170	0.110
Median	1,600	112	7.200	1.160	0.730	0.115	0.100	2.200	0.300	0.150	0.090
Analyses	187	185	187	187	187	187	187	187	187	187	187
< Limit 2/	0	0	0	0	0	3	3	0	0	0	0
Missing	0	2	0	0	0	0	0	0	0	0	0
					Combined Base Flow and Stormflow						
Maximum	13,800	1,133	21.900	7.400	2.200	1.190	0.610	5.060	1.500	0.780	0.670
Minimum	26.0	1	2.000	0.070	0.140 1/	0.020 1/	0.020 1/	0.040	0.010 1/	0.010 1/	0.010 1/
Average	1,880	150	7.390	1.190	0.750	0.130	0.110	2.220	0.280	0.150	0.100
Median	984	69	6.650	1.000	0.700	0.080	0.075	2.160	0.255	0.140	0.080
Analyses	242	239	242	242	240	242	241	242	242	242	242
< Limit 2/	0	0	0	0	1	10	10	0	1	1	1
Missing	0	3	0	0	2	0	1	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Codorus Creek near York, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	283	28	40.000	1.940	1.700	0.480	0.470	5.940	0.970	0.100	0.090
Minimum	54.4	3	7.700	0.600	0.460	0.020	0.020	1.620	0.050	0.020	0.010
Average	156	10	15.500	1.100	0.900	0.120	0.120	4.060	0.140	0.050	0.030
Median	155	8	13.000	1.080	0.850	0.090	0.090	4.180	0.090	0.050	0.030
Analyses	14	15	15	15	14	15	15	15	15	15	15
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	1	0	0	0	1	0	0	0	0	0	0
Spring											
Maximum	402	49	25.400	3.700	2.900	0.230	0.230	5.280	0.240	0.190	0.200
Minimum	55.5	9	6.400	0.370	0.370	0.020 1/	0.020 1/	2.640	0.060	0.020	0.010
Average	158	21	13.600	1.250	0.940	0.060	0.060	3.740	0.110	0.070	0.050
Median	154	20	12.600	1.000	0.780	0.055	0.050	3.300	0.090	0.060	0.040
Analyses	15	15	15	15	15	15	15	15	15	15	15
< Limit 2/	0	0	0	0	0	2	2	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
Summer											
Maximum	127	28	35.500	3.290	2.250	0.670	2.250	3.830	0.230	0.180	0.100
Minimum	43.0	11	4.200	0.280	0.230	0.030	0.030	1.380	0.010 1/	0.010 1/	0.010
Average	75.5	19	21.160	1.310	0.960	0.100	0.260	2.440	0.120	0.080	0.050
Median	75.0	19	23.000	1.360	0.820	0.060	0.060	2.100	0.130	0.090	0.050
Analyses	13	13	13	13	13	12	13	13	13	13	13
< Limit 2/	0	0	0	0	0	0	0	0	1	1	0
Missing	0	0	0	0	0	1	0	0	0	0	0
Fall											
Maximum	220	21	39.000	3.230	1.800	0.490	0.485	4.200	0.270	0.190	0.090
Minimum	35.0	4	6.600	0.760	0.300	0.020 1/	0.020 1/	1.440	0.060	0.040	0.010
Average	102	11	19.420	1.320	0.930	0.120	0.110	2.790	0.100	0.060	0.040
Median	86.0	11	16.450	1.155	0.970	0.060	0.050	2.750	0.085	0.060	0.045
Analyses	14	14	14	14	14	14	14	14	14	14	14
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0

1/ analytical detection limit

2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Codorus Creek near York, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	2,230	892	33.700	2.900	2.000	0.420	0.350	5.500	0.410	0.310	0.240
Minimum	151	10	5.600	0.460	0.400	0.050	0.050	2.760	0.040	0.020	0.010
Average	673	151	10.280	1.210	0.870	0.170	0.160	4.040	0.160	0.070	0.030
Median	475	76	8.600	1.070	0.800	0.170	0.170	4.180	0.145	0.060	0.020
Analyses	47	47	47	46	47	47	47	47	46	47	42
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	1	0	0	0	0	1	0	5
Spring											
Maximum	4,300	3,690	20.600	12.840	1.960	1.830	0.780	4.840	2.200	0.130	0.050
Minimum	210	10	4.300	0.350	0.220	0.020	0.020	2.640	0.050	0.020	0.010
Average	1,290	543	8.800	2.070	0.690	0.250	0.160	3.740	0.320	0.060	0.010
Median	783	53	7.500	0.840	0.540	0.090	0.090	3.840	0.120	0.060	0.020
Analyses	33	33	33	33	33	33	33	33	33	33	31
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	2
Summer											
Maximum	2,690	903	27.000	3.300	1.500	0.450	0.450	6.400	1.200	0.210	0.180
Minimum	86.1	24	6.200	0.800	0.600	0.065	0.065	1.500	0.090	0.070	0.010
Average	501	255	13.360	1.430	0.950	0.150	0.140	2.190	0.330	0.110	0.070
Median	265	172	12.600	1.310	0.930	0.130	0.115	2.000	0.275	0.110	0.080
Analyses	34	34	34	34	34	34	34	34	34	34	34
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
Fall											
Maximum	2,110	1,005	19.100	4.300	2.030	0.260	0.260	4.220	1.540	0.170	0.120
Minimum	94.0	10	4.900	0.540	0.440	0.040	0.040	1.680	0.070	0.040	0.010
Average	559	255	9.900	1.700	1.130	0.120	0.120	2.820	0.340	0.100	0.050
Median	520	146	9.400	1.480	1.070	0.103	0.103	2.640	0.250	0.100	0.050
Analyses	23	21	24	24	24	24	24	24	24	24	24
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	1	3	0	0	0	0	0	0	0	0	0

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[1] analytical detection limit

[2] number of analyses below detection limit

Seasonal combined flow nutrient statistics, Codorus Creek near York, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	2,230	892	40.000	2.900	2.000	0.480	0.470	5.940	0.970	0.310	0.240
Minimum	54.4	3	5.600	0.460	0.400	0.020	0.020	1.620	0.040	0.020	0.010
Average	554	117	11.550	1.180	0.880	0.160	0.150	4.050	0.150	0.060	0.030
Median	370	31	9.100	1.080	0.800	0.143	0.140	4.180	0.120	0.060	0.020
Analyses	61	62	62	61	61	62	62	62	61	62	57
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	1	0	0	1	1	0	0	0	1	0	5
						Spring					
Maximum	4,300	3,690	25.400	12.840	2.900	1.830	0.780	5.280	2.200	0.190	0.200
Minimum	55.5	9	4.300	0.350	0.220	0.020 1/	0.020 1/	2.640	0.050	0.020	0.010
Average	935	380	10.300	1.820	0.770	0.190	0.130	3.740	0.250	0.060	0.030
Median	463	37	9.500	0.890	0.665	0.080	0.075	3.730	0.120	0.060	0.020
Analyses	48	48	48	48	48	48	48	48	48	48	46
< Limit 2/	0	0	0	0	0	2	2	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	2
						Summer					
Maximum	2,691	903	35.500	3.300	2.250	0.670	2.250	6.400	1.200	0.210	0.180
Minimum	43.0	11	4.200	0.280	0.230	0.030	0.030	1.380	0.010 1/	0.010 1/	0.010
Average	383	190	15.520	1.390	0.950	0.130	0.170	2.260	0.270	0.100	0.070
Median	182	76	13.300	1.320	0.900	0.100	0.100	2.000	0.180	0.100	0.070
Analyses	47	47	47	47	47	46	47	47	47	47	47
< Limit 2/	0	0	0	0	0	0	0	0	1	1	0
Missing	0	0	0	0	0	1	0	0	0	0	0
						Fall					
Maximum	2,110	1,005	39.000	4.300	2.030	0.490	0.485	4.220	1.540	0.190	0.120
Minimum	35.0	4	4.900	0.540	0.300	0.020 1/	0.020 1/	1.440	0.060	0.040	0.010
Average	386	157	13.410	1.560	1.060	0.120	0.120	2.810	0.260	0.080	0.050
Median	184	21	10.300	1.385	1.000	0.100	0.090	2.640	0.160	0.085	0.050
Analyses	37	35	38	38	38	38	38	38	38	38	38
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	1	3	0	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Codorus Creek near York, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Base Flow					
Maximum	402	49	40.000	3.700	2.900	0.670	2.250	5.940	0.970	0.190	0.200
Minimum	35.0	3	4.200	0.280	0.230	0.020 1/	0.020 1/	1.380	0.010 1/	0.010 1/	0.010
Average	124	15	17.260	1.240	0.930	0.100	0.130	3.290	0.120	0.070	0.040
Median	113	13	14.700	1.100	0.830	0.063	0.060	3.170	0.100	0.060	0.040
Analyses	56	57	57	57	56	56	57	57	57	57	57
< Limit 2/	0	0	0	0	0	3	3	0	1	1	0
Missing	1	0	0	0	1	1	0	0	0	0	0
						Stormflow					
Maximum	4,300	3,690	33.700	12.840	2.030	1.830	0.780	6.400	2.200	0.310	0.240
Minimum	86.1	10	4.300	0.350	0.220	0.020	0.020	1.500	0.040	0.020	0.010
Average	759	289	10.620	1.560	0.890	0.170	0.150	3.300	0.270	0.080	0.040
Median	461	86	9.400	1.200	0.835	0.123	0.120	3.120	0.180	0.080	0.030
Analyses	137	135	138	137	138	138	138	138	137	138	131
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	1	3	0	1	0	0	0	0	1	0	7
						Combined Base Flow and Stormflow					
Maximum	4,300	3,690	40.000	12.840	2.900	1.830	2.250	6.400	2.200	0.310	0.240
Minimum	35.0	3	4.200	0.280	0.220	0.020 1/	0.020 1/	1.380	0.010 1/	0.010 1/	0.010
Average	575	208	12.560	1.470	0.900	0.150	0.140	3.300	0.230	0.080	0.040
Median	297	40	10.400	1.180	0.830	0.103	0.100	3.170	0.150	0.070	0.040
Analyses	193	192	195	194	194	194	195	195	194	195	188
< Limit 2/	0	0	0	0	0	3	3	0	1	1	0
Missing	2	3	0	1	1	1	0	0	1	0	7

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Codorus Creek at Pleasureville, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	411	20	24.000	2.800	2.400	0.990	0.960	6.380	0.330	0.180	0.140
Minimum	101	7	1.900	0.760	0.760	0.340	0.340	2.400	0.070	0.030	0.010
Average	235	12	11.610	1.630	1.460	0.630	0.610	4.420	0.130	0.080	0.050
Median	238	13	10.200	1.580	1.425	0.660	0.660	4.560	0.100	0.060	0.030
Analyses	15	15	15	15	14	15	15	15	15	15	15
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	1	0	0	0	0	0	0
Spring											
Maximum	552	55	19.100	4.940	3.800	2.370	2.220	5.280	0.610	0.390	0.330
Minimum	115	11	6.100	0.460	0.360	0.090	0.080	3.000	0.070	0.020	0.020
Average	225	30	11.510	1.830	1.600	0.760	0.730	3.870	0.200	0.110	0.080
Median	208	28	11.000	1.750	1.480	0.670	0.640	3.550	0.170	0.085	0.070
Analyses	16	16	16	16	15	16	16	16	16	16	16
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	1	0	0	0	0	0	0
Summer											
Maximum	325	48	30.000	6.100	5.600	3.190	3.190	4.880	1.650	0.620	0.460
Minimum	60.0	12	6.300	0.490	0.200	0.030	0.020	1.680	0.110	0.010 1/	0.050
Average	119	28	19.240	2.510	2.090	1.320	1.110	2.700	0.350	0.190	0.140
Median	99.0	24	19.800	2.000	1.800	1.210	0.740	2.700	0.270	0.140	0.090
Analyses	13	13	13	13	13	13	13	13	13	13	13
< Limit 2/	0	0	0	0	0	0	0	0	0	1	0
Missing	0	0	0	0	0	0	0	0	0	0	0
Fall											
Maximum	338	130	29.000	4.560	3.850	2.090	2.040	4.400	0.380	0.240	0.120
Minimum	88.0	3	5.700	0.780	0.680	0.080	0.080	2.280	0.060	0.040	0.020
Average	168	27	15.860	2.210	1.950	0.910	0.890	3.200	0.160	0.100	0.060
Median	152	15	14.100	1.980	1.855	0.850	0.850	3.235	0.160	0.095	0.065
Analyses	14	14	13	14	14	14	14	14	14	14	14
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	1	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Codorus Creek at Pleasureville, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	9,650	1,200	43.000	4.500	3.060	1.920	1.500	5.720	1.200	0.250	0.200
Minimum	212	15	1.400	0.960	0.380	0.100	0.080	1.900	0.050	0.030	0.010
Average	1,150	274	11.720	1.920	1.140	0.400	0.370	3.410	0.320	0.070	0.040
Median	976	206	11.000	1.800	1.140	0.390	0.360	3.360	0.280	0.070	0.040
Analyses	102	102	102	102	102	102	102	102	102	102	102
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
						Spring					
Maximum	4,360	2,980	20.100	10.260	1.860	1.440	1.440	4.490	2.530	0.310	0.990
Minimum	289	19	4.700	0.440	0.260	0.030	0.030	1.500	0.060	0.030	0.010
Average	1,630	465	9.000	2.580	0.930	0.340	0.290	3.000	0.500	0.080	0.050
Median	1,260	242	8.000	1.900	0.960	0.230	0.210	3.040	0.330	0.080	0.030
Analyses	91	89	91	91	91	91	91	91	91	91	86
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	2	0	0	0	0	0	0	0	0	5
						Summer					
Maximum	3,545	2,260	27.000	6.000	4.100	3.100	3.000	3.960	3.520	0.330	0.230
Minimum	118	32	4.100	0.760	0.260	0.030	0.030	0.600	0.120	0.070	0.010
Average	829	458	10.100	2.340	1.180	0.530	0.420	2.290	0.470	0.140	0.080
Median	633	315	8.400	2.000	1.020	0.375	0.305	2.335	0.345	0.120	0.080
Analyses	90	89	90	90	86	90	86	90	90	86	86
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	1	0	0	4	0	4	0	0	4	4
						Fall					
Maximum	3,120	1,250	39.800	11.600	3.560	1.920	1.820	4.620	2.640	0.200	0.100
Minimum	167	8	3.800	0.850	0.540	0.020 1/	0.020 1/	0.040 1/	0.080	0.050	0.010
Average	979	297	9.790	2.920	1.240	0.390	0.370	2.430	0.390	0.100	0.050
Median	785	210	9.050	2.400	1.100	0.280	0.260	2.510	0.250	0.100	0.050
Analyses	83	83	80	83	83	83	83	83	83	83	83
< Limit 2/	0	0	0	0	0	1	2	2	0	0	0
Missing	0	0	3	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal combined flow nutrient statistics, Codorus Creek at Pleasureville, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	9,650	1,200	43.000	4.500	3.060	1.920	1.500	6.380	1.200	0.250	0.200
Minimum	101	7	1.400	0.760	0.380	0.100	0.080	1.900	0.050	0.030	0.010
Average	1,030	240	11.710	1.880	1.180	0.420	0.400	3.530	0.300	0.070	0.040
Median	817	188	10.800	1.780	1.140	0.400	0.385	3.430	0.270	0.070	0.040
Analyses	117	117	117	117	116	117	117	117	117	117	117
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	1	0	0	0	0	0	0
Spring											
Maximum	4,360	2,980	20.100	10.260	3.800	2.370	2.220	5.280	2.530	0.390	0.990
Minimum	115	11	4.700	0.440	0.260	0.030	0.030	1.500	0.060	0.020	0.010
Average	1,420	398	9.370	2.470	1.030	0.400	0.360	3.130	0.450	0.090	0.050
Median	972	191	8.500	1.880	0.990	0.240	0.220	3.120	0.310	0.080	0.030
Analyses	107	105	107	107	106	107	107	107	107	107	102
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	2	0	0	1	0	0	0	0	0	5
Summer											
Maximum	3,540	2,260	30.000	6.100	5.600	3.190	3.190	4.880	3.520	0.620	0.460
Minimum	60.0	12	4.100	0.490	0.200	0.030	0.020	0.600	0.110	0.010 1/	0.010
Average	740	403	11.250	2.360	1.300	0.630	0.510	2.350	0.450	0.140	0.090
Median	557	233	9.900	2.000	1.080	0.420	0.350	2.400	0.330	0.120	0.080
Analyses	103	102	103	103	99	103	99	103	103	99	99
< Limit 2/	0	0	0	0	0	0	0	0	0	1	0
Missing	0	1	0	0	4	0	4	0	0	4	4
Fall											
Maximum	3,120	1,250	39.800	11.600	3.850	2.090	2.040	4.620	2.640	0.240	0.120
Minimum	88.0	3	3.800	0.780	0.540	0.020 1/	0.020 1/	0.040 1/	0.060	0.040	0.010
Average	862	258	10.640	2.820	1.340	0.470	0.440	2.540	0.350	0.100	0.050
Median	674	159	9.400	2.300	1.140	0.295	0.290	2.640	0.220	0.100	0.050
Analyses	97	97	93	97	97	97	97	97	97	97	97
< Limit 2/	0	0	0	0	0	1	2	2	0	0	0
Missing	0	0	4	0	0	0	0	0	0	0	0

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Codorus Creek at Pleasureville, Pa., January 1987 to December 1989

Statistic	Flow cfs	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
		mg/l									
					Base Flow						
Maximum	552	130	30.000	6.100	5.600	3.190	3.190	6.380	1.650	0.620	0.460
Minimum	60.0	3	1.900	0.460	0.200	0.030	0.020	1.680	0.060	0.010 1/	0.010
Average	190	24	14.290	2.020	1.760	0.890	0.820	3.590	0.210	0.120	0.080
Median	178	19	13.600	1.835	1.600	0.720	0.673	3.480	0.165	0.090	0.070
Analyses	58	58	57	58	56	58	58	58	58	58	58
< Limit 2/	0	0	0	0	0	0	0	0	0	1	0
Missing	0	0	1	0	2	0	0	0	0	0	0
					Stormflow						
Maximum	9,650	2,980	43.000	11.600	4.100	3.100	3.000	5.720	3.520	0.330	0.990
Minimum	118	8	1.400	0.440	0.260	0.020 1/	0.020 1/	0.040 1/	0.050	0.030	0.010
Average	1,150	371	10.210	2.410	1.120	0.410	0.360	2.810	0.420	0.100	0.050
Median	843	233	9.200	2.000	1.040	0.320	0.300	2.880	0.310	0.090	0.050
Analyses	366	363	363	366	362	366	362	366	366	362	357
< Limit 2/	0	0	0	0	0	1	2	2	0	0	0
Missing	1	3	3	0	4	0	4	0	0	4	9
					Combined Base Flow and Stormflow						
Maximum	9,650	2,980	43.000	11.600	5.600	3.190	3.190	6.380	3.520	0.620	0.990
Minimum	60.0	3	1.400	0.440	0.200	0.020 1/	0.020 1/	0.040 1/	0.050	0.010 1/	0.010
Average	1,020	323	10.760	2.360	1.210	0.480	0.430	2.920	0.390	0.100	0.060
Median	737	191	9.500	1.980	1.090	0.360	0.340	2.950	0.290	0.090	0.050
Analyses	424	421	420	424	418	424	420	424	424	420	415
< Limit 2/	0	0	0	0	0	1	2	2	0	1	0
Missing	0	3	4	0	6	0	4	0	0	4	9

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Susquehanna River at Marietta, Pa., January 1987 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	61,100	42	5.200	0.730	0.410	0.150	0.150	1.800	0.090	0.040	0.010
Minimum	14,900	5	1.400	0.200	0.200	0.030	0.030	1.080	0.020 1/	0.020 1/	0.010
Average	30,100	16	2.770	0.350	0.290	0.070	0.070	1.460	0.040	0.020	0.010
Median	26,000	11	2.450	0.290	0.280	0.070	0.070	1.410	0.045	0.030	0.010
Analyses	8	8	8	8	8	8	8	8	8	8	2
< Limit 2/	0	0	0	0	0	0	0	0	1	1	0
Missing	0	0	0	0	0	0	0	0	0	0	6
						Spring					
Maximum	66,700	67	5.700	1.280	1.030	0.070	0.065	1.340	0.120	0.070	0.020
Minimum	7,890	7	2.200	0.310	0.200	0.020 1/	0.020 1/	0.660	0.040	0.010 1/	0.020 1/
Average	30,700	27	3.750	0.700	0.480	0.030	0.030	0.960	0.070	0.030	0.010
Median	20,700	24	3.500	0.510	0.390	0.030	0.030	0.940	0.060	0.030	0.020 1/
Analyses	7	7	7	7	7	7	7	7	7	7	6
< Limit 2/	0	0	0	0	0	2	2	0	0	1	1
Missing	0	0	0	0	0	0	0	0	0	0	1
						Summer					
Maximum	34,500	32	6.900	1.440	1.050	0.080	0.080	1.940	0.170	0.100	0.010
Minimum	4,580	9	2.900	0.200	0.200 1/	0.020	0.020 1/	0.260	0.060	0.030	0.010
Average	13,100	19	4.210	0.660	0.420	0.030	0.030	0.840	0.090	0.040	0.000
Median	9,350	17	4.100	0.560	0.390	0.030	0.030	0.600	0.070	0.030	0.010
Analyses	9	9	9	9	9	9	9	9	9	9	6
< Limit 2/	0	0	0	0	1	0	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	3
						Fall					
Maximum	67,900	60	6.700	0.620	0.360	0.120	0.120	1.630	0.080	0.060	0.040
Minimum	6,110	4	1.300	0.200	0.200 1/	0.020 1/	0.020 1/	0.640	0.050	0.030	0.010
Average	22,800	17	3.280	0.380	0.220	0.050	0.040	1.120	0.060	0.030	0.010
Median	17,700	9	3.300	0.380	0.220	0.040	0.040	1.180	0.060	0.040	0.010
Analyses	9	9	9	9	9	9	9	9	9	9	5
< Limit 2/	0	0	0	0	2	1	2	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	4

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal stormflow nutrient statistics, Susquehanna River at Marietta, Pa., January 1987 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
						Winter					
Maximum	192,000	350	10.000	1.700	0.670	0.240	0.240	1.720	0.520	0.050	0.010
Minimum	25,200	11	2.200	0.200	0.200	0.040	0.040	0.800	0.030	0.020	0.010
Average	76,100	90	3.710	0.720	0.360	0.090	0.090	1.310	0.110	0.030	0.000
Median	53,200	53	3.300	0.480	0.300	0.080	0.065	1.320	0.080	0.040	0.010
Analyses	19	18	19	19	19	19	19	19	19	19	8
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	1	0	0	0	0	0	0	0	0	11
						Spring					
Maximum	235,000	364	5.300	2.810	0.950	0.130	0.120	1.740	0.310	0.060	0.010
Minimum	20,300	4	2.400	0.200	0.200 1/	0.020 1/	0.020 1/	0.550	0.030	0.020 1/	0.010
Average	123,000	122	3.730	0.880	0.400	0.050	0.040	1.090	0.130	0.030	0.010
Median	129,000	91	3.550	0.745	0.365	0.057	0.050	1.070	0.125	0.030	0.010
Analyses	60	59	60	60	60	60	60	60	60	60	18
< Limit 2/	0	0	0	0	2	9	9	0	0	1	0
Missing	0	1	0	0	0	0	0	0	0	0	42
						Summer					
Maximum	87,100	169	5.800	1.400	1.050	0.125	0.125	1.940	0.230	0.050	0.020
Minimum	11,300	16	2.000	0.340	0.210	0.040	0.040	0.580	0.100	0.030	0.010
Average	41,200	65	3.570	0.830	0.510	0.070	0.070	1.310	0.130	0.030	0.010
Median	43,600	53	3.600	0.810	0.400	0.073	0.073	1.365	0.125	0.040	0.010
Analyses	8	8	8	8	8	8	8	8	8	8	5
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	3
						Fall					
Maximum	89,200	153	15.000	2.100	0.950	0.070	0.070	2.090	0.220	0.070	0.040
Minimum	10,600	15	1.000 1/	0.400	0.330	0.040	0.030	0.920	0.060	0.030	0.010
Average	56,700	79	4.810	1.200	0.590	0.050	0.040	1.460	0.120	0.040	0.010
Median	66,200	61	4.000	1.200	0.640	0.050	0.040	1.340	0.080	0.040	0.010
Analyses	7	7	7	7	7	7	7	7	7	7	5
< Limit 2/	0	0	1	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	2

1/ analytical detection limit

2/

Seasonal combined flow nutrient statistics, Susquehanna River at Marietta, Pa., January 1987 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
Winter											
Maximum	192,000	350	10.000	1.700	0.670	0.240	0.240	1.800	0.520	0.050	0.010
Minimum	14,900	5	1.400	0.200	0.200	0.030	0.030	0.800	0.020 1/	0.020 1/	0.010
Average	62,500	67	3.430	0.610	0.340	0.090	0.080	1.360	0.090	0.030	0.000
Median	48,000	41	2.900	0.440	0.300	0.080	0.065	1.340	0.070	0.030	0.010
Analyses	27	26	27	27	27	27	27	27	27	27	10
< Limit 2/	0	0	0	0	0	0	0	0	1	1	0
Missing	0	1	0	0	0	0	0	0	0	0	17
Spring											
Maximum	235,000	364	5.700	2.810	1.030	0.130	0.120	1.740	0.310	0.070	0.020
Minimum	7,890	4	2.200	0.200	0.200 1/	0.020 1/	0.020 1/	0.550	0.030	0.010 1/	0.020 1/
Average	113,000	112	3.740	0.860	0.410	0.050	0.040	1.080	0.120	0.030	0.010
Median	106,000	87	3.500	0.730	0.370	0.050	0.050	1.060	0.120	0.030	0.020 1/
Analyses	67	66	67	67	67	67	67	67	67	67	24
< Limit 2/	0	0	0	0	2	11	11	0	0	2	1
Missing	0	1	0	0	0	0	0	0	0	0	43
Summer											
Maximum	87,100	169	6.900	1.440	1.050	0.125	0.125	1.940	0.230	0.100	0.020
Minimum	4,580	9	2.000	0.200	0.200 1/	0.020	0.020 1/	0.260	0.060	0.030	0.010
Average	26,300	40	3.910	0.740	0.460	0.050	0.050	1.060	0.110	0.040	0.010
Median	14,200	23	3.800	0.640	0.390	0.040	0.040	1.000	0.100	0.040	0.010
Analyses	17	17	17	17	17	17	17	17	17	17	11
< Limit 2/	0	0	0	0	1	0	1	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	6
Fall											
Maximum	89,200	153	15.000	2.100	0.950	0.120	0.120	2.090	0.220	0.070	0.040
Minimum	6,110	4	1.000 1/	0.200	0.200 1/	0.020 1/	0.020 1/	0.640	0.050	0.030	0.010
Average	37,600	44	3.950	0.740	0.380	0.050	0.040	1.270	0.080	0.030	0.010
Median	24,700	21	3.350	0.525	0.320	0.045	0.040	1.280	0.070	0.040	0.010
Analyses	16	16	16	16	16	16	16	16	16	16	10
< Limit 2/	0	0	1	0	2	1	2	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	6

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Susquehanna River at Marietta, Pa., January 1987 to December 1989

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
						Base Flow					
Maximum	67,900	67	6.900	1.440	1.050	0.150	0.150	1.940	0.170	0.100	0.040
Minimum	4,580	4	1.300	0.200	0.200 1/	0.020 1/	0.020 1/	0.260	0.020 1/	0.010 1/	0.020 1/
Average	23,600	19	3.510	0.510	0.340	0.040	0.040	1.090	0.060	0.030	0.010
Median	18,200	17	3.300	0.410	0.280	0.040	0.040	1.180	0.060	0.030	0.020 1/
Analyses	33	33	33	33	33	33	33	33	33	33	19
< Limit 2/	0	0	0	0	3	3	5	0	1	2	1
Missing	0	0	0	0	0	0	0	0	0	0	14
						Stormflow					
Maximum	235,000	364	15.000	2.810	1.050	0.240	0.240	2.090	0.520	0.070	0.040
Minimum	10,600	4	1.000 2/	0.200	0.200 1/	0.020 1/	0.020 1/	0.550	0.030	0.020 1/	0.010
Average	102,000	107	3.800	0.870	0.420	0.060	0.050	1.180	0.120	0.030	0.010
Median	90,800	79	3.400	0.745	0.375	0.060	0.050	1.120	0.120	0.040	0.010
Analyses	94	92	94	94	94	94	94	94	94	94	36
< Limit 2/	0	0	1	0	2	9	9	0	0	1	0
Missing	0	2	0	0	0	0	0	0	0	0	58
						Combined Base Flow and Stormflow					
Maximum	235,000	364	15.000	2.810	1.050	0.240	0.240	2.090	0.520	0.100	0.040
Minimum	4,580	4	1.000 1/	0.200	0.200 2/	0.020 2/	0.020 2/	0.260	0.020 2/	0.010 1/	0.020 1/
Average	81,400	84	3.720	0.780	0.400	0.050	0.050	1.160	0.110	0.030	0.010
Median	67,000	54	3.400	0.570	0.360	0.055	0.050	1.120	0.090	0.030	0.020 1/
Analyses	127	125	127	127	127	127	127	127	127	127	55
< Limit 2/	0	0	1	0	5	12	14	0	1	3	1
Missing	0	2	0	0	0	0	0	0	0	0	72

1/ analytical detection limit
2/ number of analyses below detection limit

Seasonal base-flow nutrient statistics, Conestoga River at Conestoga, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
Winter											
Maximum	924	57	17.600	1.780	1.640	0.900	0.900	11.600	0.440	0.410	0.390
Minimum	232	2	1.100	0.340	0.250	0.040	0.040	7.320	0.090	0.080	0.060
Average	560	14	4.830	1.030	0.850	0.400	0.390	9.090	0.210	0.170	0.150
Median	540	10	3.200	1.000	0.790	0.450	0.450	8.640	0.210	0.150	0.130
Analyses	15	14	15	15	14	15	15	15	15	15	15
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	1	0	0	1	0	0	0	0	0	0
Spring											
Maximum	1,230	90	16.800	2.300	1.360	0.480	0.480	10.000	0.470	0.690	0.400
Minimum	270	16	2.700	0.370	0.320	0.020 [1]	0.020 [1]	2.200	0.150	0.060	0.050
Average	494	33	5.420	1.030	0.740	0.190	0.180	7.590	0.260	0.220	0.170
Median	420	28	3.900	1.000	0.705	0.120	0.095	8.040	0.200	0.160	0.110
Analyses	15	15	14	15	14	15	15	15	15	15	15
< Limit [2]	0	0	0	0	0	1	1	0	0	0	0
Missing	0	0	1	0	1	0	0	0	0	0	0
Summer											
Maximum	957	110	15.200	1.900	1.800	1.650	0.160	10.030	0.620	0.580	0.580
Minimum	148	14	2.900	0.340	0.200	0.020	0.020	2.760	0.210	0.120	0.090
Average	324	36	6.700	0.950	0.620	0.170	0.050	7.150	0.420	0.330	0.290
Median	268	28	4.000	0.895	0.575	0.057	0.057	7.190	0.430	0.305	0.270
Analyses	14	14	13	14	14	14	14	14	14	14	14
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	1	0	0	0	0	0	0	0	0
Fall											
Maximum	675	43	12.100	1.680	1.500	0.570	0.540	11.130	0.490	0.440	0.400
Minimum	211	3	2.600	0.230	0.230	0.070	0.060	6.360	0.160	0.120	0.020
Average	399	14	6.030	0.910	0.750	0.220	0.220	8.220	0.300	0.260	0.200
Median	346	13	4.350	0.865	0.675	0.140	0.140	8.050	0.280	0.235	0.205
Analyses	14	14	14	14	14	14	14	14	14	14	14
< Limit [2]	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0

[1] analytical detection limit

[2] number of analyses below detection limit

Seasonal stormflow nutrient statistics, Conestoga River at Conestoga, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
						Winter					
Maximum	5,920	1,540	19.300	9.220	2.980	1.710	1.410	10.400	1.870	0.960	0.800
Minimum	483	13	3.400	0.740	0.400	0.050	0.040	2.880	0.130	0.080	0.020
Average	2,130	299	9.540	2.490	1.380	0.580	0.550	6.300	0.660	0.280	0.210
Median	1,770	190	8.400	2.120	1.300	0.488	0.470	6.240	0.540	0.240	0.170
Analyses	99	99	99	99	99	98	98	99	99	99	99
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	1	1	0	0	0	0
						Spring					
Maximum	12,000	8,710	60.000	25.000	2.460	3.100	2.100	9.240	4.200	0.780	0.450
Minimum	323	22	1.000 1/	0.720	0.390	0.020 1/	0.020 1/	3.000	0.160	0.100	0.010 1/
Average	3,350	860	11.650	3.630	1.110	0.330	0.270	5.530	0.950	0.240	0.180
Median	1,930	373	8.200	2.200	1.060	0.173	0.155	5.340	0.615	0.210	0.150
Analyses	118	118	118	118	118	118	118	118	118	118	117
< Limit 2/	0	0	1	0	0	4	4	0	0	0	1
Missing	0	0	0	0	0	0	0	0	0	0	1
						Summer					
Maximum	19,000	6,140	44.000	24.000	4.000	2.300	1.870	9.200	5.170	1.310	0.740
Minimum	151	23	3.500	0.700	0.290	0.020	0.020	1.340	0.300	0.060	0.010
Average	5,080	896	8.970	3.320	1.230	0.360	0.280	3.890	1.060	0.320	0.240
Median	2,560	514	7.500	2.505	1.110	0.173	0.160	3.600	0.715	0.300	0.235
Analyses	134	134	134	134	134	134	134	134	134	134	134
< Limit 2/	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	0	0	0	0	0	0	0	0	0
						Fall					
Maximum	5,000	1,857	16.000	7.230	5.320	0.930	0.870	10.600	2.530	0.540	0.390
Minimum	420	17	1.900	0.500	0.340	0.020 1/	0.020 1/	2.640	0.160	0.130	0.040
Average	2,400	425	8.520	2.800	1.070	0.220	0.200	4.850	0.710	0.290	0.240
Median	1,960	303	8.050	2.240	1.000	0.195	0.180	4.800	0.525	0.300	0.250
Analyses	75	76	76	76	75	76	76	76	76	76	75
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	1	0	0	0	1	0	0	0	0	0	1

1/ analytical detection limit
2/ number of analyses below detection limit

	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
Statistic	cfs	mg/l									
					Winter						
Maximum	5,920	1,540	19.300	9.220	2.980	1.710	1.410	11.600	1.870	0.960	0.800
Minimum	232	2	1.100	0.340	0.250	0.040	0.040	2.880	0.090	0.080	0.020
Average	1,930	264	8.920	2.300	1.310	0.560	0.530	6.670	0.600	0.270	0.200
Median	1,690	166	7.950	2.000	1.240	0.475	0.450	6.830	0.490	0.220	0.170
NALYSES 2/	114	113	114	114	113	113	113	114	114	114	114
< Limit	0	0	0	0	0	0	0	0	0	0	0
Missing	0	1	0	0	1	1	1	0	0	0	0
					Spring						
Maximum	12,000	8,710	60.000	25.000	2.460	3.100	2.100	10.000	4.200	0.780	0.450
Minimum	270	16	1.000 1/	0.370	0.320	0.020 1/	0.020 1/	2.200	0.150	0.060	0.010 1/
Average	3,030	767	10.990	3.340	1.080	0.310	0.260	5.760	0.870	0.230	0.180
Median	1,670	330	7.650	1.980	1.000	0.165	0.150	5.500	0.500	0.210	0.150
Analyses 2/	133	133	132	133	132	133	133	133	133	133	132
< Limit	0	0	1	0	0	5	5	0	0	0	1
Missing	0	0	1	0	1	0	0	0	0	0	1
					Summer						
Maximum	19,000	6,140	44.000	24.000	4.000	2.300	1.870	10.030	5.170	1.310	0.740
Minimum	148	14	2.900	0.340	0.200	0.020	0.020	1.340	0.210	0.060	0.010
Average	4,630	814	8.770	3.090	1.170	0.340	0.260	4.200	1.000	0.320	0.240
Median	2,220	380	7.500	2.280	1.075	0.160	0.140	3.960	0.670	0.300	0.240
Analyses 2/	148	148	147	148	148	148	148	148	148	148	148
< Limit	0	0	0	0	0	0	0	0	0	0	0
Missing	0	0	1	0	0	0	0	0	0	0	0
					Fall						
Maximum	5,000	1,857	16.000	7.230	5.320	0.930	0.870	11.130	2.530	0.540	0.400
Minimum	211	3	1.900	0.230	0.230	0.020 1/	0.020 1/	2.640	0.160	0.120	0.020
Average	2,080	361	8.130	2.510	1.020	0.220	0.200	5.370	0.650	0.290	0.230
Median	1,850	208	7.800	2.120	0.960	0.190	0.180	4.840	0.485	0.300	0.250
Analyses 2/	89	90	90	90	89	90	90	90	90	90	89
< Limit	0	0	0	0	0	1	1	0	0	0	0
Missing	1	0	0	0	1	0	0	0	0	0	1

1/ analytical detection limit
2/ number of analyses below detection limit

Nutrient statistics, Conestoga River at Conestoga, Pa., January 1985 to December 1989

Statistic	Flow	Sediment	TOC	TKN	DKN	TNH	DNH	NO23	TP	DP	OP
	cfs	mg/l									
					Base Flow						
Maximum	1,230	110	17.600	2.300	1.800	1.650	0.900	11.600	0.620	0.690	0.580
Minimum	148	2	1.100	0.230	0.200	0.020 1/	0.020 1/	2.200	0.090	0.060	0.020
Average	447	24	5.710	0.980	0.740	0.240	0.210	8.020	0.290	0.240	0.200
Median	364	21	3.900	0.970	0.700	0.125	0.115	8.380	0.255	0.210	0.180
Analyses	58	57	56	58	56	58	58	58	58	58	58
< Limit 2/	0	0	0	0	0	1	1	0	0	0	0
Missing	0	1	2	0	2	0	0	0	0	0	0
					Stormflow						
Maximum	19,000	8710	60.000	25.000	5.320	3.100	2.100	10.600	5.170	1.310	0.800
Minimum	151	13	1.000 1/	0.500	0.290	0.020 1/	0.020 1/	1.340	0.130	0.060	0.010 1/
Average	3,440	664	9.760	3.120	1.200	0.380	0.330	5.070	0.870	0.280	0.210
Median	1,940	330	8.000	2.260	1.100	0.240	0.220	4.840	0.620	0.260	0.210
Analyses	426	427	427	427	426	426	426	427	427	427	425
< Limit 2/	0	0	1	0	0	5	5	0	0	0	1
Missing	1	0	0	0	1	1	1	0	0	0	2
					Combined Base Flow and Stormflow						
Maximum	19,000	8,710	60.000	25.000	5.320	3.100	2.100	11.600	5.170	1.310	0.800
Minimum	148	2	1.000 1/	0.230	0.200	0.020 1/	0.020 1/	1.340	0.090	0.060	0.010 1/
Average	3,080	588	9.290	2.870	1.150	0.360	0.310	5.430	0.800	0.280	0.210
Median	1,790	270	7.600	2.100	1.080	0.230	0.210	5.100	0.560	0.260	0.200
Analyses	484	484	483	485	482	484	484	485	485	485	483
< Limit 2/	0	0	1	0	0	6	6	0	0	0	1
Missing	1	1	2	0	3	1	1	0	0	0	2

1/ analytical detection limit
2/ number of analyses below detection limit

SUSQUEHANNA RIVER BASIN COMMISSION
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